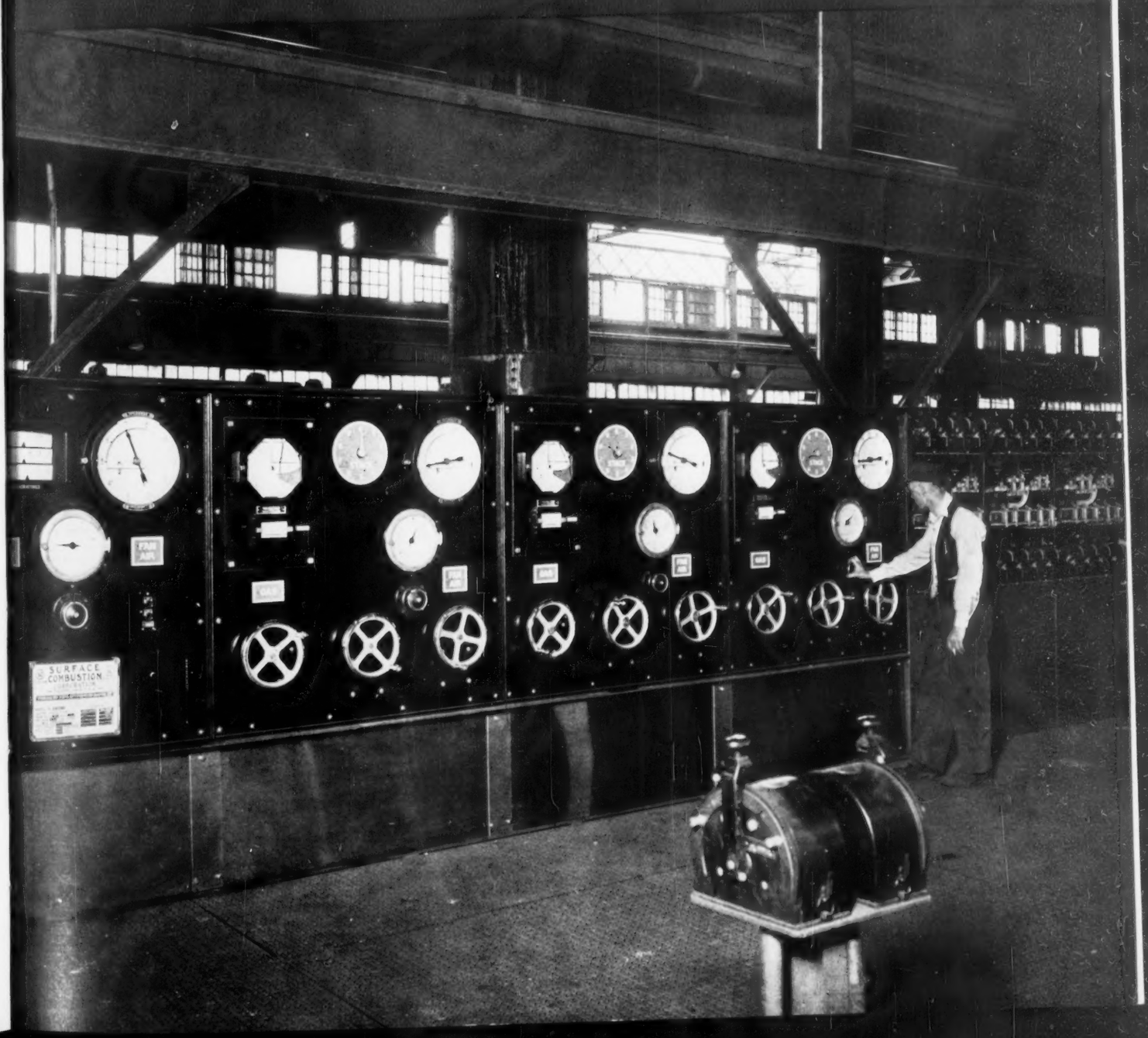
Instruments

THE MAGAZINE OF Measurement and Control

Vol. 11
JULY
1938
No. 7



THE NEW TAG RECORDER-CONTROLLER

•

10 & 12 INCH CHARTS

•

"ON-OFF" CONTROL Model for a Majority of Industrial Requirements

THROTTLING CONTROL Model for Services Involving Apparatus Lag

NEARLY forty years of constant development mark the progress of TAG Control Design. And, reflecting this steadily improved engineering practice, TAG now presents another featured instrument in its new line of handsomely styled Indicating and Recording Controllers.

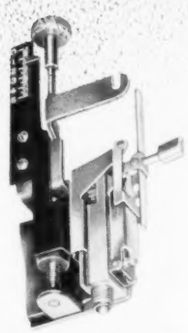
The TAG Recorder-Controller illustrated here embodies all the exclusive, modern features and dependable precision found in the new TAG Line. The flapper mechanism has been redesigned and is now available in either "ON - OFF" or adjustable THROTTLING type. It is perfectly balanced and practically frictionless.

With full sized 12 inch chart, this instrument provides the longest pen travel—4 3/4 inches. The open graduations insure closer control setting and more easily read records. With 10 inch chart, a pen travel of 3 11/16 inches is secured.

The interchangeable tube system—the lifeline of the instrument—is laboratory - calibrated at the factory. Tested, approved and standardized with stainless steel parts. It can be replaced readily and checked at one temperature only, without the necessity of recalibrating all points of the range.

Ask for your FREE copy of TAG Catalog No. 1060-I.

Shown above is the redesigned, non - adjustable flapper mechanism in its simplest form . . . the ideal pilot for a great majority of control applications.



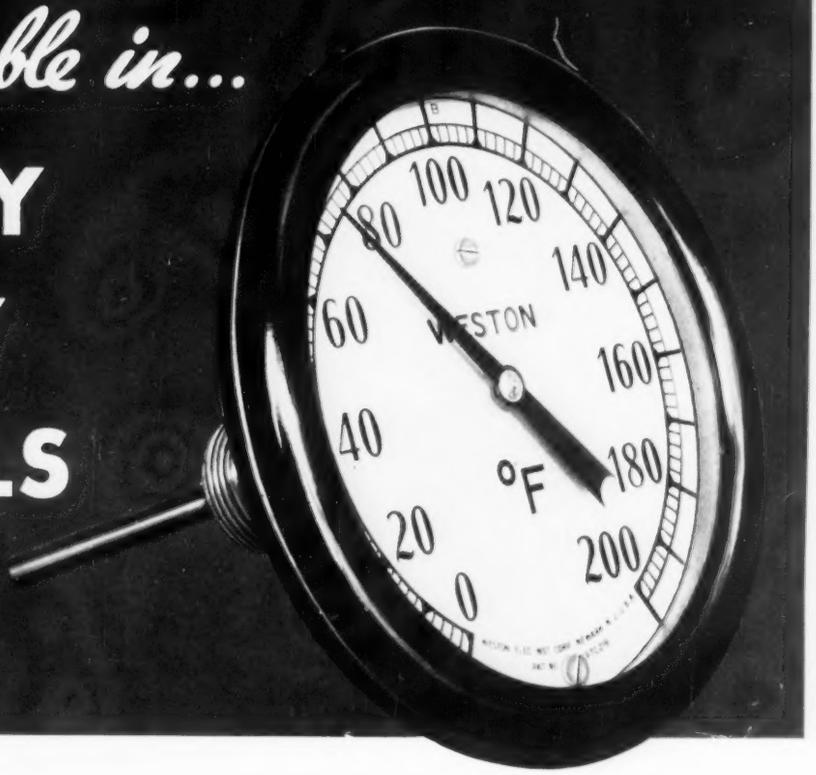
Shown above is the adjustable, calibrated flapper mechanism. Its design permits easy adjustment of throttling range to coincide with great apparatus lag.

C. J. TAGLIABUE MFG. CO.

Park & Nostrand Ave's., Brooklyn, N. Y.

Now Available in...

HEAVY DUTY MODELS



WESTON Industrial Temperature Gauges

WESTON
(all-metal)
Laboratory Thermometers

Eliminate costly breakage. Individually calibrated and tested ...stainless steel construction... accuracy guaranteed by WESTON.

- Moisture and fume-proof cases . . . scale lengths 9" and 12" (head diameters 5" and 6")
- All-metal, corrosion-proof construction (no glass tubes, no fluids). Virtually unbreakable
- Easy to read . . . dial type scale with large scale markings
- Accuracy guaranteed 1% over entire scale
- No capillary correction ever necessary
- Ranges from −40° to 1000°F. (−10°C. to 400°C.)
- Standard stem lengths from 2½" to 24"
- Also available in standard models with head diameter 3"

Send coupon for complete information on all WESTON Temperature Gauges.

WESTON ELECTRICAL INSTRUMENT CORPORATION
591 Frelinghuysen Avenue, Newark, N. J.

Please send full particulars on all WESTON Industrial and Laboratory Thermometers.

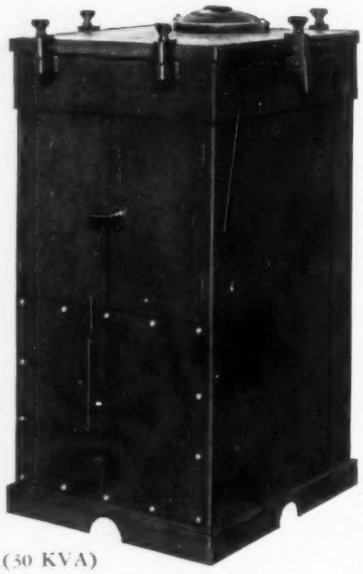
Name _____

Address _____

City _____ State _____

ROLLER-SMITH AUTOVOLT

AUTOMATIC CONSTANT VOLTAGE REGULATORS



(50 KVA)

Built in capacities from 150 Watts to 25 KVA (and higher); have these inherent outstanding and important features necessary for constant voltage regulation:

1. *No moving parts.*
2. Handling of any load from zero to full capacity without impairing the regulation in *any* way.
3. Do *not* distort the wave form.
4. *Nothing* to wear out. *No* attention or maintenance required.
5. A *higher* accuracy of regulation is available than with any other line voltage regulator handling equivalent loads and variations of loads.
6. Reasonably large variations in the power factor of the loads do *not* impair the accuracy of the regulator.
7. A *selection* of *constant voltages* is available by merely turning a knob.

(150 Watts)

For further details send for Catalog J-10, Section 5 and its Price Sheet.

ROLLER-SMITH COMPANY
Electrical Measuring and Protective Apparatus

MAIN OFFICE: 2132 Woolworth Bldg., New York

WORKS: Bethlehem, Pa.

Sales Agencies in Principal Cities in U.S.A. and Canada

Instruments
THE MAGAZINE OF MEASUREMENT and CONTROL

VOL. 11 No. 7

JULY, 1938

FRONT COVER: Control board for soaking pits, National Tube Co.

EDITORIAL COMMENT 173

NEW INSTRUMENTS ..... 174 and 187
Indicators, recorders, controllers, inspection devices, etc., for plant, field and laboratory

FORD POWER PLANT INSTRUMENTATION 182
3—Turbine Instrumentation
By W. W. Dulmage

HARDNESS MEASUREMENTS 185
The Pyramidal-indenter Method
By S. R. Williams

INSTRUMENTATION FORUM 190
Chlorination control problem;
Live-tissue temperature measurement problem

BUYERS' GUIDE A3

MANUFACTURERS' NEW LITERATURE ..... (Insert)

ADVERTISERS' INDEX ..... (Insert)

Published Monthly on the 15th by
THE INSTRUMENTS PUBLISHING COMPANY
1117 Wolfendale Street, Pittsburgh, Pa.

RICHARD RIMBACH, Managing Editor
M. F. BEHAR, Editor

BRANCH OFFICES
Boston: James Condon, 52 Irving St. (Lafayette 7913)
New York: R. K. Farnham, 118 E. 28th St. (Lexington 2-4637)
Chicago: William Farnham, 201 N. Wells St. (Andover 4180)
Cincinnati: E. Eggers, 3642 Brentwood Ave. (East 3174)
Philadelphia: R. K. Farnham, 1533 Cherry St. (Rittenhouse 2530)

Annual Subscription: U. S. $2.00. All other countries $3.00 *payable in advance* (remit by New York draft).

Copyright 1938 by The Instruments Publishing Company.

Entered as second-class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

INSTRUMENTS The Magazine of MEASUREMENT and CONTROL

M. F. BEHAR
EDITOR

IN THIS ISSUE

So rapidly does the Ford Motor Co. expand and modernize that by the time a magazine is able to publish detailed descriptions of installations, new units are being added. For example, when Power Superintendent W. W. Dulmage began his articles on the famous No. 1 Power Plant, in our May issue, the total capacity was 235,000 kw. and the simplified layout drawn a month ago and published in our June issue was accurate; but Mr. Dulmage now starts his third article by saying that installation of another 110,000 kw. unit will be begun when this issue of *Instruments* goes to press! Somewhat breath-taking.

Last month Professor Williams began his treatment of the diamond pyramid indenter method (of measuring hardness) by discussing the method itself. Now he describes its embodiments.

Again we are impelled to remark that the instrument industry brings out more new devices during depressions than in good times: forty-odd new products — including some which are not instruments but belong in columns dedicated to the information of instrument *users*. These columns are on pages 174-181 *and* 187-189; the items are more or less in order of length, and we hope you like this make-up.

THE FRONT COVER

shows an installation of Askania Regulator Co. control equipment for soaking pits at the National Tube Co., McKeesport, Pa. The pits were built by Amsler-Morton Co., Pittsburgh, Pa.

INSTRUMENTATION MAKES JOBS

INSTRUMENTATION makes jobs by making possible the creation of new industries which would not even have been launched without it. Example, the refining of crude oil into numerous products, each with chemical and physical properties exquisitely balanced and accurately controlled to meet specifications unheard of before this era of instrumentation. Example, the manufacture of modern long-mileage tires which would be impracticable without automatic temperature and pressure time cycles automatically coordinated.

Instrumentation makes jobs by expanding industries whose growth depends upon the existence of instrument-created industries. Example, the modern automobile industry. Take away the instrument-made high-power knockless gasolines that sell for 10 or 12 cents (plus taxes) a gallon; take away the instrument-made tires that give 20,000 miles of good service; take away the instrument-made alloys, and so few cars would be sold that hundreds of thousands of auto workers would be laid off.

Instrumentation makes jobs by expanding industries whose growth depends upon ability to reduce prices of products in order to win the mass markets. Examples, the already-cited oil, tire and automotive industries; other examples (under "R" only), radio, rayon and refrigerators.

Instrumentation makes jobs in America by creating new domestic industries of three types: (1) New industries which largely or entirely supplant competitive imports. Example, rayon plants employing 50,000 wage-earners receiving $50,000,000 a year and selling their $180,000,000 yearly output to 4000 mills employing hundreds of thousands of Americans. (2) New industries which absorb the surplus products of our fields and forests and create demands for new crops. Examples, some of the plastics and other chemical industries. (3) New industries which tend to relieve our dependence on strategic and critical materials such as tin, tungsten, sisal and jute. Take instruments away from rayon plants and mills, and we Liberty-worshippers would support more worshippers of the Emperor-God. Take instruments away from the new industries of the second group and our crops would be at the mercy of world prices. Take instruments away from the third group and our State Department would have to accept terms laid down by some gangster nations.

Yes, Instrumentation makes millions of jobs in thousands of not-so-apparent ways.

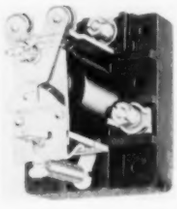
THE MONTH'S NEW INSTRUMENTS

Ratio Meter

Directly indicating the ratio of two (d-c.) currents or voltages, this new instrument consists of a pair of extremely light crossed coils swinging on steel pivots in jewel bearings and moving in a straight-line magnetic field. Steel pivots are at a distance from magnetic field, and are magnetically shielded. Two horseshoe magnets placed end-to-end produce the straight-line flux across middle of assembly. Ratio Meter may be used with currents from 0.5 microamp. up to 1 or 5 amps. (depending on model) and from 0.1 millivolt to thousands of volts.—*Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York City.*

Heavy-duty "Midget" Relays

New Heavy-duty Midget Relays are announced, rounding out maker's line of magnetic relays. These new relays are furnished with extra-large fine silver-to-silver contacts to provide a maximum contact rating of 10 amps. up to 125 volts a.c., 10 amps. up to 22 volts d.c., or 2 amps. from 23 to 125 volts d.c. They are available only with single-pole, double-break, normally-open contacts. Their construction otherwise and coil data are the same as maker's "Bulletin 106" relays.—*Ward Leonard Electric Co., 38 South St., Mount Vernon, N. Y.*



Water Temperature Controller

Two new controllers are announced for warm-water heating systems: "No. 204" (vertical bulb-stem) and "No. 205" (rear angle connection, illustrated). Both are for 110-volt a-c. supply and will control motors up to 1 h-p. They may control either the firing device of the heating system, or a water circulator. Working range 110-220° F., with setting-point and differential adjustable from outside.—*H. A. Thrush & Co., Peru, Indiana.*

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

When writing to manufacturers directly, please mention this department as your source of information.

Or write to Information Section, Instruments Publishing Company.

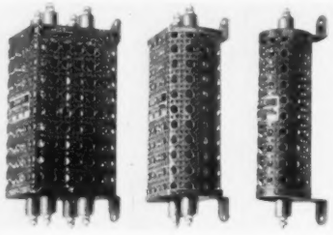
This department is in TWO Sections. Other items, just as important, though mostly longer, on pages 187-8-9.

Projector-arc Rectifier

Designed to improve efficiency of all measuring and inspection instruments and machines using 6-mm. carbon arc lamps, new portable Rectifier No. 1072 converts 115-volt a.c. to 60-volt 5-amp. d.c., uses new Raytheon RX-207 tube for rectification and a built-in current-limiting transformer instead of wasteful external ballast resistors. Comes ready-to-use.—*Raytheon Mfg. Co., 142 Willow St., Waltham, Mass.*

Cage Type Resistors

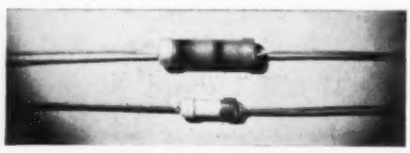
A new standardized series of ventilated cage type resistors is illustrated: for one, two or four resistors 1" diam. by $6\frac{5}{8}$" long. Overall dimensions are



$2\frac{7}{8}$", 2-29/32", and $4\frac{1}{4}$" respectively, by 9-9/16" long; mounting centers are $8\frac{3}{8}$". Cage resistors of different sizes and types are also available from maker.—*Ohmite Mfg. Co., 4835 W. Flournoy Street, Chicago, Illinois.*

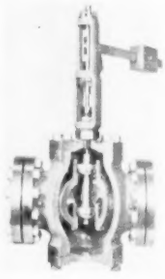
Carbon Resistors

New series of carbon resistors, with leads in line with axis of body, have tinned copper wire and metal cap assembly rigidly attached to each end of the carbon unit. "Type X-1" rated from $\frac{1}{10}$ to $\frac{1}{2}$ watt, and "Type X-2" from $\frac{1}{2}$ watt to 1 watt, are available in resistance values from a few ohms to several megohms.—*Erie Resistor Corp., Erie, Penna.*



Control Valves

For use with maker's "Series 90" and "Series 100" controllers, for steam, air, oil, water (hot or cold), and most any gases, "Series 42" balanced lever valves embody features including: roller guided top works insuring free valve movement, stem roller guided top and bottom, Nitralloy rollers and roller pins, double or single seat and renewable seat rings. Any type inner valve: (1) parabolic; (2) flat type with bevel seat; (3) V-port with bevel seat; (4) V-port, non seating. Sizes: $\frac{1}{2}$" to 3" screwed ends; 1" to 12" flanged ends (any type).—*A. W. Cash Co., Decatur, Ill.*



Pneumatic System For Pressure Telemetering

Remote pressure readings are said to be obtained quickly and accurately at distances up to 1000 ft. with new "Ashcroft Pneumatic Transmitting Duragauge." Pneumatic system is balanced air relay of non-bleed type said to minimize air consumption. Case is moisture-, fume- and dust-proof. Panel or flush mounting. Etched aluminum 10" dial. "Duragauge" Bourdon spring construction. Minimum 0-60 lbs./in.^{2}, maximum 0-10,000 lbs./in.^{2}.—*Ashcroft Gauge Div., Manning, Maxwell & Moore, Bridgeport, Conn.*

"Ground-Ohmer"

New "Model JP Ground-Ohmer" for measuring ground resistance has same type of measuring system, same generator, etc., as "Model C" which it supersedes. Difference is size reduction, to 9" x 6" x 8" and weight reduction to about 13 lbs. Available in 5 different range combinations: 10 & 100 ohms, 10,100 & 1000 ohms, and 100, 1000 & 10,000 ohms; this last made up with or without the fourth terminal for geophysical measurements. — *Herman H. Sticht & Co., 27 Park Place, New York City.*

S-M-O-O-T-H VOLTAGE CONTROL for A.C. circuits

The Type "TH" Transtat is the new continuously variable auto-transformer regulator . . . the ideal voltage control for a.c. circuits. It offers high efficiency, good regulation, great flexibility and dependable construction at moderate cost. Standard types are available for controlling voltage to single-phase and polyphase loads rated 10 Kva. and smaller, 50 or 60 cycles, 115, 230 or 460 volts. May we send you bulletin 51-1 which contains complete data?

TRANSTAT
VOLTAGE REGULATORS

AMERICAN TRANSFORMER CO.
178 Emmet St. Newark, N. J.

SENSITIVE ELECTRONIC AC VOLTMETER
MODEL 300

10 to 100,000 cycles
Range .001 to 100 volts r.m.s.
Logarithmic voltage scale
A-C operation, 115 volts 60 cycles
Accurate and stable calibration
New principle of operation

Write for Bulletin 2D for complete data.

Ballantine Laboratories, Inc.
BOONTON NEW JERSEY

pH Test Paper

Used like ordinary litmus paper but capable of approximate measurement, new "Hydrion Wide Range Test Paper" gives five color changes:

pH	2	4	6	8	10
Color	red	orange	yellow	green	blue

Is supplied in cartons of 400 strips or bottles of 1000 strips.—*R. P. Cargille, 118 Liberty St., New York City.*

Pulsation Damper

A pressure-snubbing or gage-throttling device designated as "Gauge Saver" which damps severe pressure pulsations so that the gage pointer remains steady, saves wear on the gauge movement, is especially recommended for reciprocating pump or pipe line service. It also prevents corrosive material from getting into the Bourdon spring, and acts as a safety device in case overpressure should fracture the Bourdon spring as the bulb will collapse and prevent escape of pressure to the gauge.—*Ashcroft American Gauge Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn.*

Motor Thermostat

For use in fractional horsepower motors, new "Klixon" overheat protection thermostat is said to be one of simplest motor-protection units made, contains no magnets, springs, or toggles, consists of a small thermostatic bimetal disk placed next to a heater wire. Contacts, welded to the disk, provide positive action. Thermostat interferes with motor's work only when overheating is a definite danger. In operation, it follows closely the heat rise in the motor windings, compensates automatically for varying ambient *vs.* load conditions. Applicable over complete range of single-phase a-c. fractional horsepower motors up to and including 1 h.p. 110 and 220 volts. Available with either manual or automatic reset.—*The Spencer Thermostat Company, Attleboro, Mass.*

"Push-button Tuned" Signal Generator

"Push-button tuning" makes its appearance in testing-instrument field, being embodied in new model of this maker's signal generator, a survey having shown that 90% of radio receivers use only five i-f. frequencies. Four r-f. frequencies being provided in addition, it is claimed that "Model 582-A" permits aligning practically all radio sets, using push buttons only. New model has also a manually-tuned band from 85 kc. to 15 Mc. on fundamentals and to above 60 Mc. on harmonics; is said to be "the only visual alignment system which automatically and instantly centers the carrier frequency, locks the horizontal sinusoidal sweep and synchronizes the vertical frequency moduated signal without the necessity for a single extra control."—*Supreme Instruments Corp., Greenwood, Miss.*

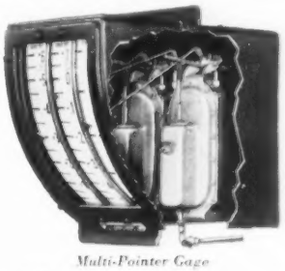
BAILEY METERS

METERS and CONTROL *for Boiler Room Service . . .*

Boiler Meters Indicate, record and integrate Steam Flow from the boiler, record Air Flow supplied for combustion and record Flue Gas Temperature. The use of this meter reduces fuel cost, lessens maintenance and outage, lowers standby costs, and adds capacity.

Bailey Boiler Meter

Multi-Pointer Gages for indicating drafts, pressures, differentials are available with any number of pointers from one to twelve. They are actuated by sturdy yet sensitive diaphragm units.



Multi-Pointer Gage

Flow Meters. For indicating, recording and integrating the flow of steam, feed water, compressed air and other fluids.

Coal Meter

Granular Material Meters For accurately measuring the flow of coal or other granular materials in gravity chutes from overhead bunkers. The total quantity of granular material is shown on a large illuminated counter which may be easily read at a distance of 50 feet.

Control Systems. Make possible the everyday operation of equipment for steam generation and utilization at test efficiencies. They are applied to the control of combustion, feed water, superheat, desuperheat and other factors.

Complete Information on any of the above Bailey products will be gladly furnished upon request.

G-7

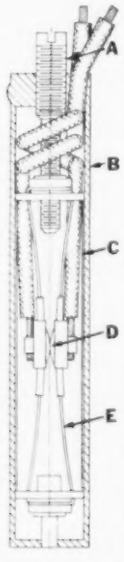
BAILEY METER COMPANY
1041 Ivanhoe Rd., Cleveland, Ohio

Universal Tachometer

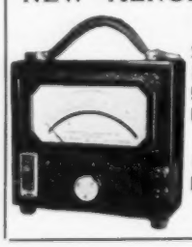
New model "Jagabi Universal" hand tachometer measures any speed from 30 to 40,000 r.p.m. with only three ranges, is said to be equivalent in speed coverage to six-range hand tachometers: for each range, pointer makes two turns around dial, covering a scale 13" long. Length of each range permits a wide variation in speed to be observed, such as from 300 to 4000 r.p.m., without stopping to change range. Instrument employs same centrifugal fly-ball governor principle as maker's "Type C", but has been redesigned to include ball-bearings, a knife-edge pointer, a rotating gear shift and other refinements; is supplied complete with carrying case and accessories. Two ratings are available: 30 to 40,000 r.p.m. and 25 to 30,000 r.p.m.—*James G. Biddle Co., 1211 Arch St., Philadelphia, Pa.*

Electric-contact Type Temperature Control

Illustration shows, approx. two-thirds actual size, section of "Fenwal Cartridge Thermoswitch" said to represent an entirely new type of control device. Temperature-responsive element is outer tube *B* which encloses all working parts (insulated by *C*). Its movement relative to non-expanding parts *E* causes circuit to be closed or opened at silver contacts *D*, the differential being 0.1°F. Control point is set by means of screw *A* (or calibrated dial-and-knob in another model). Range is 0-400°F. and it is said that no damage results from exposure to 300°F. above control point, below maximum of 500°F. Model illustrated is for mounting on bracket or inserting through $\frac{5}{8}$" hole; another has a $\frac{1}{2}$" st'd pipe-thread collar for leak-proof installation; another is waterproofed for total submersion within controlled bath.—*Fenwal Inc., 16 Maple St., Danvers, Mass.*



NEW "ALNOR" PORTABLE PYROMETER

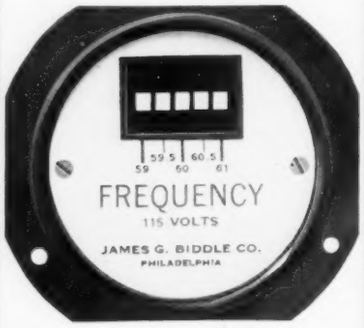


Shock Resisting, Floating Movement, Has 5" Mirrored Scale Metal Case.

Write for Details

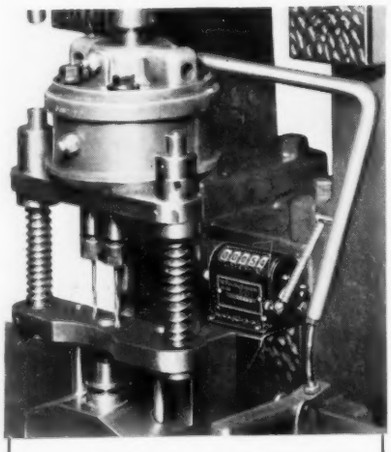
ILLINOIS TESTING LABORATORIES, Inc.
142 W. Austin Ave.
Chicago, Illinois

"FRAHM"
VIBRATING - REED FREQUENCY METER



Because it has no pivots, jewels or rotating parts, and is independent of wave form, the Frahm Frequency Meter offers an exceedingly simple and reliable way to indicate power frequencies between 15 and 500 cycles per second. Miniature, switchboard and portable types are available. Write for descriptive Bulletin 1555-I.

JAMES G. BIDDLE CO.
ELECTRICAL INSTRUMENTS
1211-13 Arch Street Philadelphia, Pa.



Check Production with Work Fixture Counters

Small parts production can be checked off with much time saved by having counters permanently attached to work fixtures. This fixture mounts on a drill press for drilling two holes in a pinion blank at one stroke. A *Productimeter* registers directly the number of blanks drilled.

DURANT MFG. CO.
1930 N. Buffum St., Milwaukee, Wis.
182 Eddy Street, Providence, R. I.
Sales Offices in all principal cities

TELL US WHAT YOU WANT TO COUNT

Automatic Time Switch

New "Type TSA-14" automatic time switch for use in process timing, etc., has an all-glass cover to facilitate inspection, contact-making mechanism driven through spur gear train by a Telechron motor, dial marked in percent of total time. Percent of "on" time may be varied by user by rotating dial until desired percent is opposite mark. Silver contacts are mounted on the brushes which bear on rotating cams. Steps in cams snap contacts open and closed at desired intervals. Pipe nipple on the die-cast base allows easy mounting in a knockout of any convenient junction or switch box. Silver contacts are rated 10 amps. at 230 volts. Special switches of this type can be furnished to meet unusual requirements.—*General Electric Co., Schenectady, N. Y.*

Photoelectric Exposure Meter

"Weston Junior" employs same type of stable Photronic Cell and sensitive instrument movement used in Weston "Universal" and "Cine" exposure meters. It has a circular cell-window on one side, designed to cover a uniform angle comparable to that of normal camera lens; on opposite side is a "full-vision" dial; user can take readings while keeping an eye on the scene. Light values are indicated by a pointer on lower scale which has 24 divisions, each corresponding to a difference of $\frac{1}{2}$ an "*f*" stop. Above this scale is a knob-operated "calculator band" for rapid determination of all possible aperture-shutter combinations for any particular light value and film speed. Provision is made for 17 film speed ratings from 0.7 to 200 Weston, 17 aperture stops from *f*:2 to *f*:32, and 27 shutter speed settings from 60 sec. to 1/1000 sec. Range: at low end, *f*:2 and 1/5 sec.; at high end, the most brilliant beach and snow scenes do not require use of multipliers or adapters.—*Weston Electrical Instrument Corp., 591 Frelinghuysen Ave., Newark, N. J.*

The All Purpose
AIR VELOCITY METER

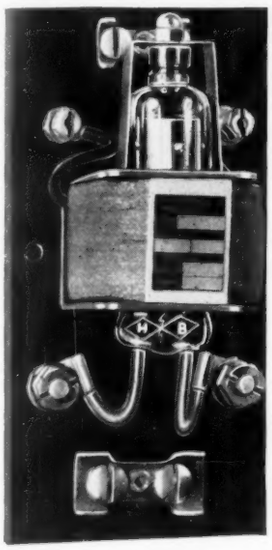
"Alnor" Velometer

Instantaneous Direct Reading

No Timing
No Calculations
Write for Literature

ILLINOIS TESTING LABORATORIES, Inc.
142 W. Austin Ave. Chicago, Illinois

A New and Better **A-C RELAY**



THE IDEAL RELAY for operation in conjunction with contact-equipped instruments, and for numerous other applications. Only one moving part. Mercury-to-Mercury break. Listed under Re-examination Service of Underwriters' Laboratories, Inc. 30-amp. or one h-p. a-c rating.

Request Bulletin "A"

H-B ELECTRIC COMPANY, Inc.

2502 N. Broad St. Philadelphia, Pa.

Surface Temperatures

Flat Stationary or Moving Curved Surfaces

The "Alnor" Combination Pyrocon

Ideal for rolls, molds, plates, platens and plastic material temperatures.

Write for bulletin.

Illinois Testing Laboratories, Inc.

142 W. Austin Ave. Chicago, Illinois

★ *NATIONAL* ★

RHEOSTATS

Ask for Catalog No. 5

National Electric Controller Co.
5317 Ravenswood Ave., Chicago, Ill.

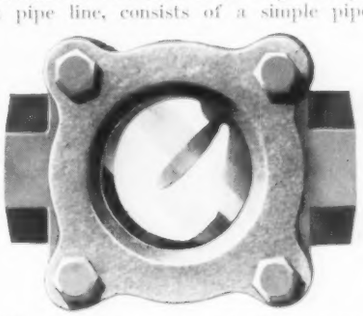
Universal pH Indicator

Designated "Universal" by reason of its versatility, this new instrument reads directly in pH with glass, quinhydrone, hydrogen or any other electrode following the Nernst equation. When used with glass electrode system furnished, simply setting dial of temperature compensator adapts entire pH scale to meas-

urements at that temperature. (This applies also if quinhydrone electrode is substituted for glass.) Equipped with voltage scale as well as pH scale, it is also used in oxidation-reduction potential measurements, and in current and resistance determinations. It can be used with external circuits of much higher resistance than the 100 to 300 megohms of glass electrode supplied with it. New glass electrode is small, comparatively rugged, requires only a 5 ml. sample for measurement. Everything necessary for glass electrode measurements is included with instrument. Other features include: quartz insulation, where necessary, to avoid leakage errors; a separate battery compartment to prevent corrosion; unimpaired accuracy in atmospheres <95% relative humidity; ability to make sodium corrections, where necessary, directly in pH units.—*Leeds & Northrup Co., 4955 Stenton Ave., Philadelphia, Penna.*

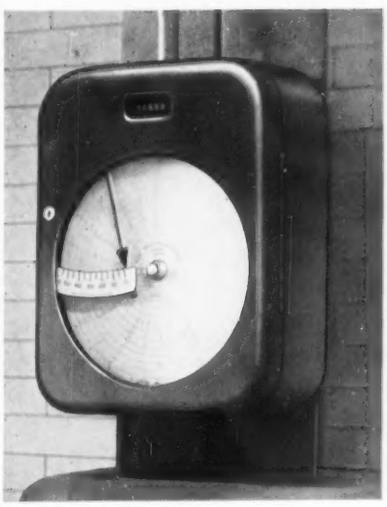
Flow-rate Perceptor

New "F & P Bull's Eye Sight Flow Indicator" is used for determining whether or not fluid is flowing through a pipe line, consists of a simple pipe



fitting having two round sight glasses located on opposite sides and held in position by removable bolted cover plates. Neoprene or thiokol packing is used. Between the glasses is a flapper suspended in such a manner that it hangs against a seat when there is no flow; as soon as flow commences flapper swings outward and upward as shown in illustration. Available in ½" to 3" sizes; regularly in bronze, aluminum, C.I. or 18-8 stainless alloy; also other materials; screwed or flange connections.—*Fischer & Porter Co., 114 W. Penn St., Germantown, Philadelphia, Pa.*

COCHRANE
FLOW METERS



One of Two Cochrane Recorders Operating from Same Orifice in Plant of RCA Mfg. Co.

HOW COCHRANE DUAL TRANSMITTER FURNISHES TWO RECORDS OF FLOW FROM ONE ORIFICE

HERE is an effective metering hook-up for dual use—as, for example, where a plant generates steam and sells part to an adjacent plant. Duplicate Cochrane Recorders installed in each plant furnish duplicate records of the steam flow on separate charts and integrators.

Cochrane Electric Flow Meters provide accurate records of fluid flow any distance from the pipe lines. The galvanometer null principle guarantees precision measurements. Time and money saved by the use of Cochrane Flow Meters are a big factor in manufacturing profits. That is why many of the country's leading industrial plants are standardizing on Cochrane Flow Meters.

Write for details of the dual recorder hook-up mentioned above and for other interesting facts about Cochrane Flow Meters.

COCHRANE CORPORATION

Specialists in Steam Control Since 1869

3120 N. 17th ST., PHILADELPHIA, PA.

Nine-inch Oscillograph

New "Precision Type 169" cathode-ray oscillograph with 9" screen was developed to meet critical laboratory requirements, "incorporates the largest array of

controls yet provided in a commercial instrument." Two independent power supplies, for C-R tube and for amplifiers and sweep circuit. Two identical amplifiers provide push-pull electrostatic deflection. Compensation makes for linear response of amplifier at extremely low frequencies and also well above a-f. range. A third amplifier modulates the grid of the C-R tube. Controls of wide-range linear sweep circuit are free from interaction. Amplifiers permit more than twice full-scale deflection before overload. Other features: single-trip, maximum wave expansion, return trace elimination, deflection with or without amplifiers, positioning and focusing controls, etc.—*Allen B. Dumont Labs., 2 Main Ave., Passaic, N. J.*

Electrometric and Volumetric Apparatus

"Fisher Titrimeter" is said to be the first all-purpose electrometric titration apparatus to be made available for volumetric analysis; will perform acid-base, oxidation-reduction, pH and conductivity titrations, and measure d-c. voltage and resistance; also is useful in preparing solutions of a definite pH or normality. Titrations are made through detection, amplification and observation of electrical changes between electrodes in a solution before, at and after the end point. One of unique features is use of cathode-ray detector tube (the type called "magic eye" in radio) as end-point indicator. Complete apparatus consists of three main assemblies: (1) *Stand*, wherein electrodes, beaker support, burettes, stirrer, stopcocks and electron-ray tubes are assembled in small area; (2) *Qualitative Unit* which serves as a means for amplifying electrical potentials picked up at electrodes and for detecting changes in amplified potentials by means of the "magic eye"; (3) *Quantitative Unit* which permits the measurement of potentials at electrodes in absolute units so that changes of potential upon addition of titrant can be studied and plotted in curve form. This unit also is employed in making pH titrations. Numerous accessories are available.—*Fisher Scientic Co., 711 Forbes St., Pittsburgh, Pa.*

KNOW—DON'T GUESS

The Engelhard Portable Pyrometer
The quality of your product or the production you may obtain may depend upon accurate temperatures. Economy demands instruments of reliability. Use the ENGELHARD Portable Millivoltmeter Pyrometer to protect your product and your production.

Charles Engelhard, Inc.
90 CHESTNUT ST. NEWARK, N. J.
Manufacturers of Pyrometers, Resistance Thermometers, Exhaust Gas Analysers, Flue Gas Analysers, Thermocouples.

HÖPPLER VISCOSIMETER

according to the FALLING BALL PRINCIPLE

Range: From 0.01 to 1,000,000 Centipoises
Accuracy: 0.1% to 0.5%

Model B

For determining the ABSOLUTE viscosity of gases, oils, greases, varnishes, viscous tars, or syrups. Direct readings in Centipoises (or Centistokes). Small sample (30 cc.) required. Results consistent and reproducible.

Bulletin HV 251 on request

JENA KPG All-Glass Stirrer for Vacuum or Pressure

Replaces clumsy mercury seal. No supplementary seal or stuffing box needed. Recommended for all types of chemical work, particularly for organic, electro-chemical and physical research.

Leaflet JS 262 on request

Available at leading laboratory supply dealers

FISH-SCHURMAN CORPORATION
250 East 43rd Street New York City

U. S. Agents
Jena Glass Works, Schott & Gen.

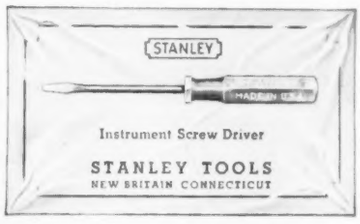
Fish-Schurman

Electronic Voltmeter

"Model 330" sensitive electronic a-c. voltmeter is said to be 100 times more sensitive than conventional type of vacuum-tube voltmeter. It covers the range of voltage from 1 mv. to 100 volts in five decade steps. Logarithmic scale, graduated 1 to 10, permits switching in decade steps with but one scale to read; provides uniform percentage accuracy of reading over the entire range. An auxiliary uniform scale in decibels is also provided. Frequency range of 10 to 100,000 cycles covers audio, supersonic and carrier-current frequencies. Accuracy (about 2%) is unaffected by fluctuations in line voltage, variation in tube characteristics, circuit constants and temperature. Instrument measures $4\frac{1}{2}$"x$5\frac{3}{4}$"x 11"; weighs $9\frac{1}{2}$ lbs.—*Ballantine Laboratories, Inc., Boonton, N. J.*

Instrument Screwdriver

Illustration shows cellophane package of new No. 1017 Instrument Screw Driver (10c) for instruments, eye glass frames, small auto parts, locks, clocks,



fishing reels, typewriters, radios, etc. Hexagon handle is of amber colored "Stanloid"; $1\frac{1}{2}$" blade is of tempered steel, nickel-plated.—*Stanley Tools, New Britain, Conn.*

Automotive Vehicle Speed Signal

"Speed Reminder" comprises a contact-making wind-vane installed on engine behind fan, a knob installed on dash-board, a rod connecting knob and adjusting-screw of contacting device, a bell, necessary wiring, etc. After installation, car or truck is driven at desired speed and knob-turned until bell rings. It is claimed that "bell will then ring every time you reach this speed" and that device "is as accurate as your speedometer." Annoucement does not mention what prevents bell ringing when motor is raced with vehicle at rest, nor what makes bell ring when vehicle exceeds set speed coasting with engine idling.—*Homestead Valve Mfg. Co., Coraopolis, Penna.*

The Hand that Holds a TIMER...

holds the reins of ECONOMY and EFFICIENCY in every Industrial and Scientific activity.

GALLET TIMERS

(as well as GALCO, SECURITY and GUINAND TIMERS)

set the world's standard for lasting dependability

Complete Catalog 6F FREE

JULES RACINE & COMPANY

20 WEST 47TH STREET, NEW YORK

TEST MAGNETIC PROPERTIES OF YOUR STEELS

RAWSON FLUXMETER

SIMPLEST AND MOST EFFICIENT

Bulletin 504

Dynamometers, wattmeters, milliammeters and voltmeters. Also ultra-sensitive meters both for A.C. & D.C., fluxmeters, electrostatic voltmeters from full scale 120 volts to over 20,000 volts, thermocouples, earth current meters, cable testers, etc.

Acknouledged leaders in development of high sensitivity meters

RAWSON Electrical Instrument Co.

CAMBRIDGE, MASSACHUSETTS

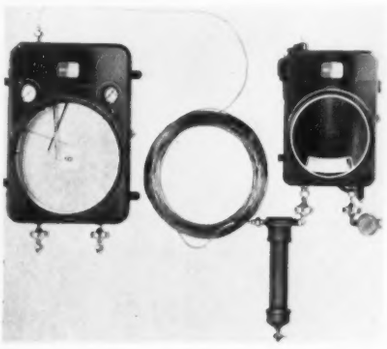
15 E. 26th St., New York

1313 W. Randolph St., Chicago

Special Apparatus Built to Order

Pneumatic Telemetering System

A pneumatic telemetering system for recording and automatically controlling temperature, flow, pressure, and liquid level, known as "Bristol's Metavane Sys-



tem," consists of (1) transmitter which is a modified "Free Vane" pressure controller with 15 lbs./in.^{2} air supply, so arranged that the primary measuring element varies the control point to maintain automatically in the connecting tubing a pressure corresponding or equivalent to the value of the measured flow, temperature, etc.; (2) receiver which is an indicating, recording or controlling pressure gage with 0-15 lbs./in.^{2} range but calibrated in terms of the variable measured at the transmitter. Distance between transmitter and receiver may be several hundred feet. New system is said to have a wide field of application in industry and it obviously is especially suited for use in plants where explosive fumes are present.—*The Bristol Co., Waterbury, Conn.*

Time Meter

New Cramer Running Time Meter registers the operating time of the circuit, apparatus or system to which it is connected. Driven by a slow-speed, self-

starting synchronous motor, it is made in two types: total hours, and total minutes. A five-digit counter indicates in tenths up to 9999.9 and repeats. Meter is connected in parallel with machine or apparatus of which total operating time is to be registered. Housing is of molded Bakelite, available in black with silver dial or brown with bronzed dial.—*R. W. Cramer & Co., 67 Irving Place, New York City.*

Stop and consider this unique combination of features of the new

ROTAMETER

1. A twist of the hand loosens the two knurled nuts and permits the end fittings to swivel about to any desired position. Thus horizontal connections can be made in any direction whatsoever. Vertical connections also provided.

2. By unscrewing the knurled nuts altogether the meter comes apart completely so that the glass metering tube can be pulled out WHILE IN ITS CASE for cleaning or for exchange. No danger of striking the glass tube against a metal part.

3. Glass metering tubes well prorected by enclosing metal tube having two slots to admit light and permit observation of float position.

4. F & P precision-bore, interchangeable glass metering tube with F & P fusod colored graduations. Tolerance of tube diameters guaranteed less than 0.0005".

5. All parts finished in satin chromium.

6. New low prices.

7. Panel mounting brackets furnished without extra charge.

F & P rotameters measure rate of flow of any liquid, vapor or gas from "faucet drip" to hundreds of gallons or cubic feet per minute. This includes all alkalies and any acid except HF. Their only moving part is a top-shaped float which rises in a tapered tube as flow increases. Position of float indicates rate of flow. Capacity scale is etched directly on tube. Remote recorders and integrators can also be furnished.

"Always be sure it's an F & P Rotameter"

Fischer & Porter Co.

115 West Penn Street

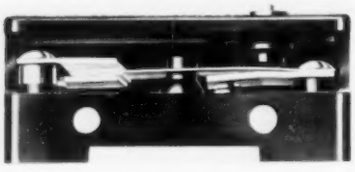
Germantown, Philadelphia, Pa.

Coördinated Automatic Combustion Control

New Hays System of automatic combustion control permits mounting all instruments and controls upon a single panel, is completely electrified, is said to minimize costs of installation and maintenance. Maker is said to be "the only manufacturer of control systems to supply the enclosed type of switch." An electric system transmits impulses of Master Control to remote boiler controls and is used also where necessary to position any individual valve, damper, rheostat or lever direct from Master Control. Four main units are (1) Master Control responding to steam header pressure; (2) Air-flow Control; (3) Fuel feed control; (4) Furnace draft control. System is of "metering type"—the variables which the system controls being measured as are the corrections, which are made simultaneously with the necessity for them as indicated by the instruments and extend only enough to restore balance. There is said to be no tendency to hunt.—*The Hays Corporation, Michigan City, Indiana.*

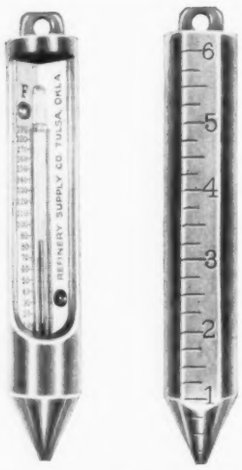
Snap-action Switch

Said to embody results of development by maker since 1927, new "Mu-Switch," of which illustration shows cut-away view, is suitable for electric control cir-



cuits at rating to 10 amp. at 110 volts a.c., 1,200-watt non-inductive load, ½-hp. inductive load. It is supplied as a single-pole, single-throw unit, normally open; as an s-p.s-t. unit, normally closed, and as an s-p.d-t. switch. Outside dimensions approx. 1½" long × ⅞" high × 11/16" wide. Mechanism is designed for quick break under pressures from 4 oz. to 3 lbs. (to customers' requirements) exerted on a small stud protruding through housing cover. Initial pressure on this stud builds up a pressure in a leaf spring, causes spring to snap contact open. Studs can be fitted with a leaf-spring operating arm and a plunger-type spring-operated mechanism. Contact spring is in a single-piece assembled with the contact member. There are no hinges or other rubbing surfaces. Adjustments are permanently made at the factory. Mounting can be in any position.—*Tobe Deutschmann Corp., Canton, Mass.*

SOLENOID VALVES
for Air, Gas, Oil, Water, Steam, Chemicals
SPRAY NOZZLES
For Humidifying and Air Washing
Home & Industrial Humidifiers
Supreme Electric Products Corp.
99 Mt. Hope Ave. Rochester, N. Y.

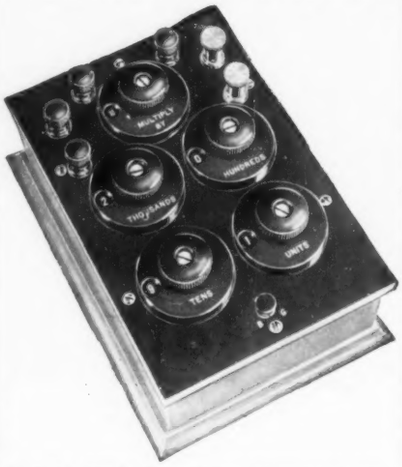


R. S. THERMO PLUMB BOB

Consists of a regular six inch 15 ounce brass plumb bob, hollowed out and equipped with a thermometer for reading the temperature of the oil, and to insure correct temperature reading a small amount of oil is retained in bottom of plumb bob. The thermometer is supplied with two ranges, either minus 20 to 120° F. or plus 30 to 220° F. On the back of the plumb bob there is a six inch scale, which can be used to gauge the amount of water in the bottom of the tank.

THE REFINERY SUPPLY CO.
631 E. 4TH ST. TULSA, OKLA.

WHEATSTONE BRIDGE



A high grade laboratory instrument containing 4 rheostat decades of 9 coils each, total resistance 9999 ohms, and a ratio dial affording 7 ratios, .001 to 1000. Rheostat coils are guaranteed accurate to within 1/10%, ratio coils to within 1/20%.

Described in Bulletin 100 which also describes Rubicon resistance standards, shunts, resistance boxes and several types of Wheatstone and Kelvin Bridges.

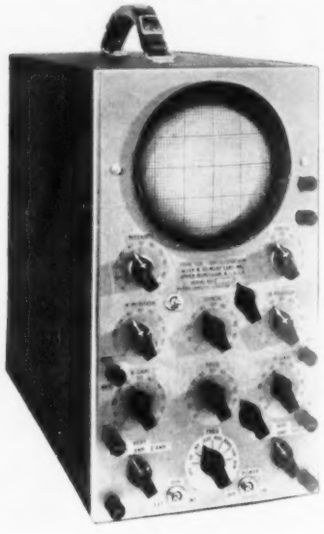
RUBICON COMPANY
Electrical Instrument Makers
29 North Sixth St. Philadelphia, Pa.

Solenoid Control Relays

Two new solenoid control relays are designed to provide pump-free control without danger of overheating or otherwise injuring the solenoid coil or closing rectifier. "Type PB-63" and "PB-64," for moderate and heavy duty respectively, are similar except for contact ratings. Solenoid closing coil circuit is de-energized at a definite point regardless of control switch contacts or other maintained-closed contacts. Overheating of solenoid coil is prevented even if closing contacts of control switch are kept too long in closed position. Relays have a main and an auxiliary element: main element is instantaneous in drop-out and is provided with a pair of auxiliary, normally-open contacts, which seal it in and thus assure operation in case control switch makes only momentary contact. Auxiliary element, a hinged armature relay with two pairs of contacts, is energized by a solenoid cut-off, or "aa" switch, operated by solenoid mechanism and closing at end of mechanism closing stroke. Winding of auxiliary element may remain continually connected without harm.—*General Electric Co., Schenectady, N. Y.*

Five-inch Oscillograph

Representing a modification and elaboration of "Type 168" (see *Instruments*, Oct. 1937, page 259) new "Type 171" five-inch cathode-ray oscillograph has



three additional controls, provides for a beam switch, grid amplifier, single-sweep feature, and symmetrical horizontal deflection. Single-sweep feature, for facilitating study of transients, controls linear sweep circuit so that it does not sweep until some form of tripping pulse is applied to grid of discharge tube. Grid modulation amplifier lends itself to television work. Return trace elimination signal has been brought to the front panel.—*Allen B. DuMont Labs., 2 Main Ave., Passaic, N. J.*

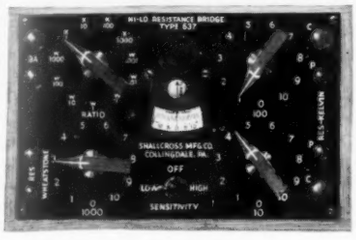
"NEW INSTRUMENTS"
Continued on Pages 187-9

AKRA-OHM

SHALLCROSS Wire Wound

Permanent Value Resistors

Developed for use in scientific and industrial control equipment and measurements. Also for use in laboratory and experimental instruments.



We manufacture resistance boxes, decade potentiometers, Wheatstone Bridges, resistance standards up to 100 megohm all wire wound.

Send for Bulletin 140H

SHALLCROSS MFG. CO.

COLLINGDALE, PA.

SCHOPPER Precision

TENSILE TESTERS

25,000-lb. models, and others for accurate work to 1/3200 oz.

Variable Speeds from 2" to 20" per minute.

New recording model shown here.

This is but one of an extensive line of special testing machines representing the new, correct techniques. Write for bulletins concerning **your** problems.

BENDING TESTERS

Angles 110° to 1°. Loads 100 lb. to ¼ oz. Plots angles with load.

IMPACT TESTERS

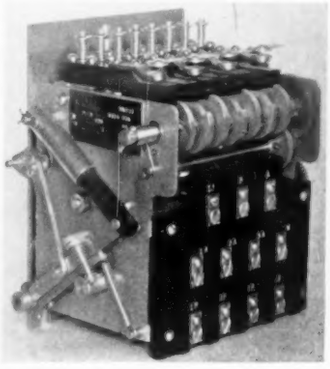
ALL SYSTEMS. 120 ft.-lb. down to the one hundredth part of 1/3 ft.-lb.

TESTING MACHINES, Inc.

466 W. 34th Street, New York

Instantaneous Reset Timer

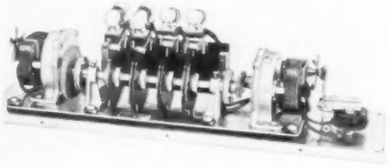
New "Polyflex" is a synchronous motor driven time delay relay designed for applications which do not require frequent adjustments of timing intervals.



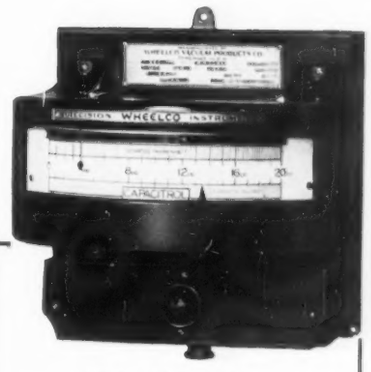
It is particularly suited for applications where a timing interval between the functioning of two or more contacts is required. It may be adjusted in the field to provide timing sequences with its clutch coil either (1) energized or (2) de-energized during the timing interval: (1) Starts timing when a control circuit is closed; in modified form, begins timing upon the momentary closure of control circuit and resets when the timing interval has expired. (2) Commences timing interval when control circuit is opened and resets when control circuit is closed. One, two or three pairs of contacts in a standard frame may be provided for controlling the same number of external circuits. Each contact is electrically independent of the others and is readily adjustable to operate according to cycles which are also independent except as to maximum duration.—*Eagle Signal Corp., Moline, Ill.*

Cycle Controller

New "Model 635" time cycle controller utilizes varied speeds on its single camshaft, a principle said to have never been available previously in a commercial con-



troller. Otherwise it is generally similar to "Model 611" (*Instruments*, Jan. 1937, page 5; May 1937, page 127). Principal new feature is that motors with different speeds are placed at either end of camshaft and, utilizing speed reducers and overriding clutches at proper places on shaft, cycling operation is accelerated or slowed at any point desired in the cycle. Acceleration and deceleration, too, may be completely automatic, controlled by a mercury switch operated by one of the cams, or controlled by push-button. New controller employs unbreakable mercury switches (fully described in Jan. 1937 item).—*Electric Switch Corp., 1205 Union St., Columbus, Indiana.*



"Sales Mean Jobs"

CAPACITROL

Temperature Control

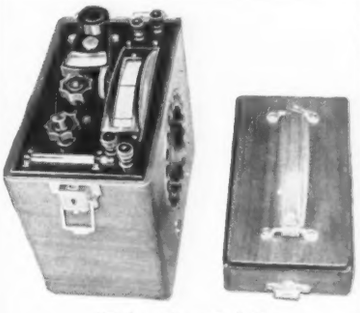
Positive hairline temperature Control at low cost—all electrical operation and rugged construction prevents lag time—there are no cams, motors, mechanical parts or mechanical contacts. It automatically maintains the desired temperature as selected on the face of the indicating Pyrometer.

Send for Complete Data & Information

PRICE **$125**

WHEELCO INSTRUMENTS CO.

1933 SO. HALSTED STREET, CHICAGO, ILL.



"Sales Mean Jobs"

WHEELCO

Portable Potentiometer

with removable cover

- Specially designed for field and laboratory use.
- Hand drawn millivolt scales, or temperature scales in Fahrenheit, Centigrade, or both.
- Accuracy and sensitivity is far higher than any temperature calibrated pyrometer.
- Made in four different models, having special equipment for different classes of service work.
- Complete data and information furnished on request.

Write for Catalog "G"

Wheelco Instruments Co.

1933 So. Halsted St. Chicago, Ill.

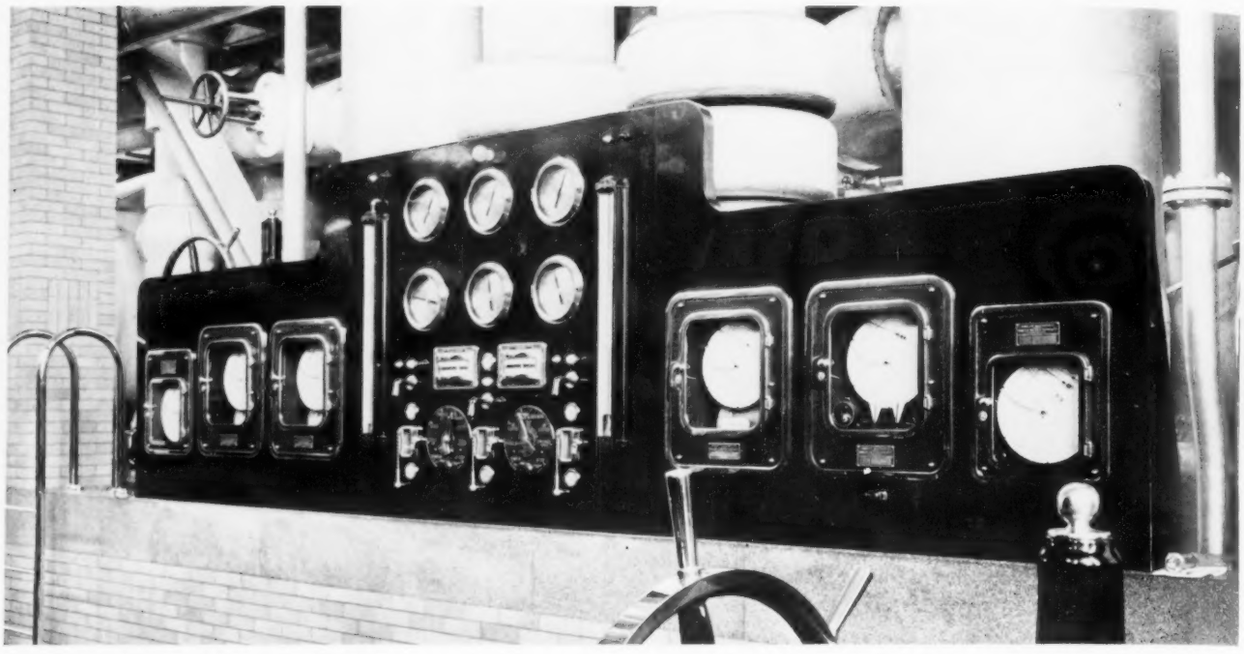


Fig. 1. Control Board for Nos. 1 & 2 Turbines

Turbine Instrumenta at

Third Article on No. 1 Power Plant Instrumentation

By W. MAC

IN the first two articles the writer described the instrumentation related to steam generation, from combustion control to the boiler-feed problem and boiler accessories. Following a logical itinerary, we now take you to the turbo-generator room where steam is first utilized. This room, when the July issue of *Instruments* goes to press, will be a scene of unusual activity, for we will then be installing the condenser unit for Nos. 7 and 8 turbines: the third 110,000-kw. machine. This will give us a total of 345,000 kw. However, for descriptive purposes, there is variety enough in our three main control boards on the five turbines now in operation.

INSTRUMENTATION OF NO. 1-2 UNIT

THE control board (Fig. 1) for the No. 1-2 110,000-kw. unit (Fig. 2) includes meters for recording and totalizing the flow of steam and condensate, recorders and gages for recording and indicating the pressures and temperatures of the steam at important points throughout the unit, and a recorder for recording the temperature of the air leaving the generator air coolers. Also included on the panel board are instruments indicating the electrical load on the unit and the speed of the machine. In addition to measuring instruments there are signals to condenser pit and main switchboard, and signal alarms denoting excessive generator air temperatures and low oil pressures. For protection against damage due to failure of any part of the unit the panel board includes safety switches for instantaneous closing of the valves in the steam lines to the unit.

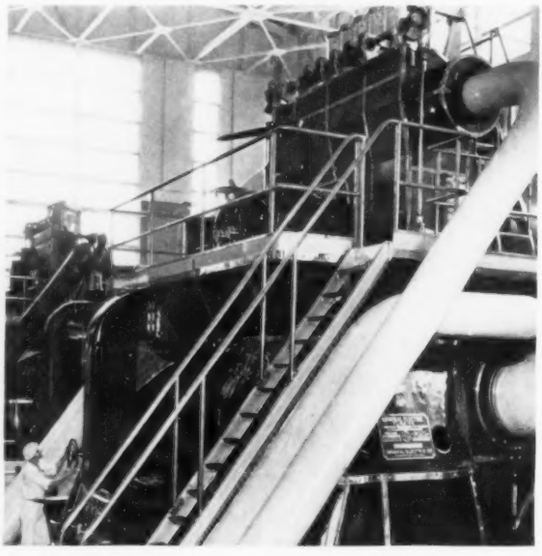


Fig. 2. Nos. 1 & 2 110,000-kw. Turbo-generators (3 & 4 in background)

Steam Meters. All the steam generated by No. 1 and No. 3 boilers is consumed by the No. 1-2 110,000-kw. unit. The steam flows from these two boilers discharge into a common header, and from this header run two 10" supply lines feeding the turbine (see diagram on page 166, last month's article). One line enters the steam chest on the north side, the other on the south side. These two lines being dimensionally equal, supplied from a common header and discharging into the same steam chest, steam flows through both are equal at all times that valves are open. Two multifunction fluid meters record and totalize the steam supplied to the high-pressure turbine. In each steam meter the flow mechanism is operated by the differential pressure across an orifice in the pipe line, acting on a mercury-sealed Ledoux bell, which is so shaped that its vertical movement is proportional to rate of flow (square root extraction). All steam meters record in pounds per hour on 12" round charts with 24-hour rotation period.

Generator Air Temperature Recorder. This instrument records the temperature of the air leaving the upper and lower generator air cooler. Its pen-arm is driven by a helical tube coil connected by a copper capillary to a cylindrical bulb, the whole system charged with nitrogen gas under initial pressure. This recorder

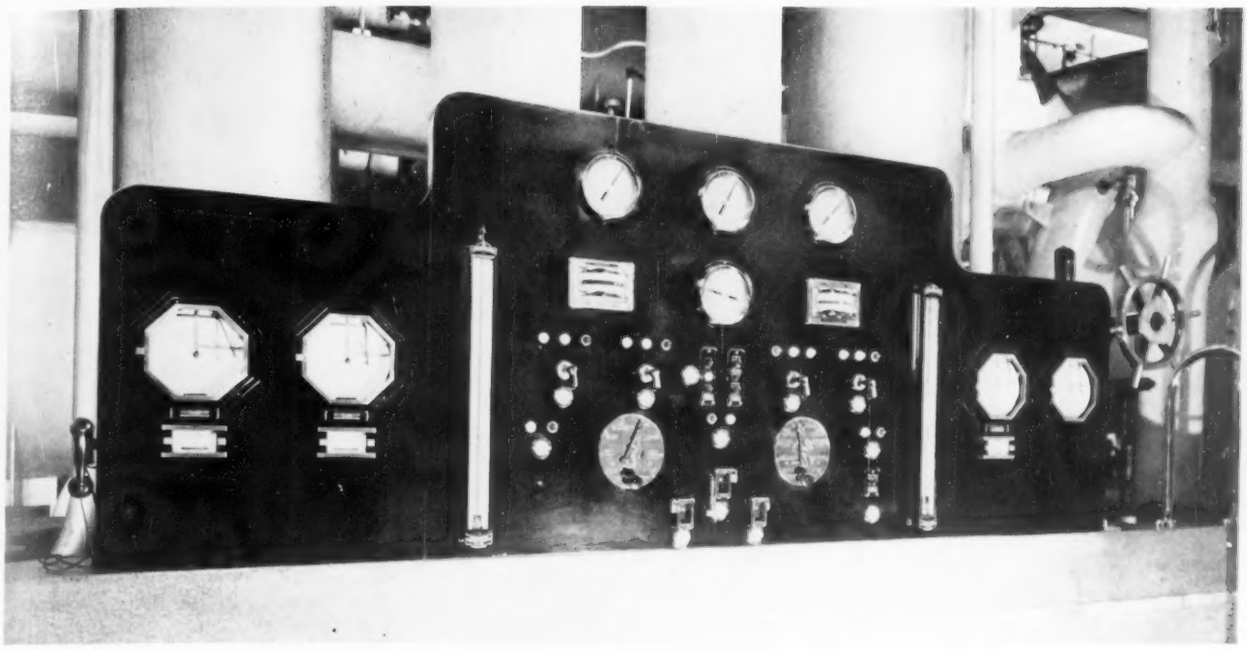


Fig. 3. Control Board for Nos. 3 & 4 Turbines

...ent... at Ford Power Plant

By W...MAGE

Power Department, Ford Motor Co., Dearborn, Mich.

also contains two electric contact-making devices for operating relays to alarm signals when the generator air temperature reaches a predetermined maximum.

Steam Pressure Recorder. This recorder is equipped with three pressure units, recording pressures at: (1) inlet to high-pressure turbine; (2) pressure out of high-pressure turbine; (3) inlet to low-pressure turbine.

Condensate Flow Meter. This instrument records and totalizes the volume of condensate discharged from the condenser. Its principles have been explained above.

Pressure Gages. (1) main header steam pressure; (2) valve chest steam pressure; (3) primary admission steam pressure; (4) first stage steam pressure; (5) discharge to pre-heater; (6) admission to low-pressure unit; (7) mercury-column vacuum gage. All but this last are of the Bourdon type, of the highest grade.

Signal to Switchboard. This is a Selsyn-operated system used by the engineer on the turbine and the operator on the switchboard (upstairs) to convey to each other their exact procedure in starting up or stopping a turbo-generator.

No. 1 Throttle Trip—North. In case of damage to the north supply line, such as bursting of a line, breaking of valve at turbine, this line may be isolated by shutting off the steam to it by throwing this trip.

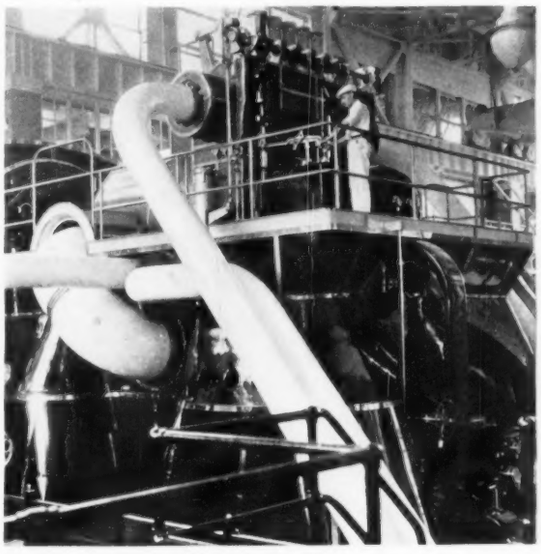


Fig. 4. Nos. 3 & 4 Turbo-generators, 110,000 kw., condensing.

No. 2 Throttle Trip—South. Same as the preceding.

Master Trip. By throwing this trip both north and south throttle stop valves are closed completely throttling off the steam supply to turbine.

Signal to Condenser Pit. This is another Selsyn-operated signal system. It is used by the operation on the turbine floor and the operators in the condenser pit to convey to one another in advance their next step in starting or stopping the unit, so that each will be prepared to act accordingly.

Miscellaneous. Also on the board are a mercurial barometer, a load indicator and a speed indicator.

INSTRUMENTATION OF NO. 3-4 UNIT

FUNCTIONALLY similar to its mate but different in interesting details noted below, the panel board (Fig. 3) for No. 3-4 (Fig. 4) 110,000-kw. unit includes meters and instruments for recording and totalizing the flow of steam and condensate; recording and indicating steam pressures and temperatures at important points; recording the temperature of the air leaving the upper and lower generator air coolers; indicating the electrical load on the unit, the speed of the machine; signals to condenser pit and to switchboard; alarm signals for excessive generator air temperatures and low oil pressure; and three safety switches for instantaneous closing of the valves in the steam lines leading to the unit.

Steam Meters. Two steam lines supply steam to No. 3-4 (see last month's diagram), therefore two steam meters are necessary to record the flow of steam to the

unit. Since the steam in these two lines is supplied from the same manifold and discharges into the same steam chest, these lines, too, like those to the No. 1-2 unit, have equal steam flows. The steam meters differ from those on the No. 1-2 board in that they are electrical rather than mechanical. In each, the primary element is a flow nozzle and the secondary element a mercury manometer which varies an electric current. This electrical method of measurement obviates the need of floats, levers, gears or stuffing boxes. The low-pressure side of the U-tube is a contact chamber in which there are a number of overhanging steel rods of varying lengths placed above the mercury column, so that as the mercury rises it makes contact with one conductor after another. These are the terminals of a calibrated rheostat governing the flow of current to the receiving instruments on the panel-board. These two meters record and totalize the flow of steam to the turbine, and each has a second pen for recording the steam pressure.

Condensate Flow Meter. This meter records and totalizes the flow of condensate discharged from the unit. It also has two helical-element thermal systems recording the temperature of the steam before and after it enters the high-pressure turbine.

Generator Air Temperature Recorder. This instrument records the temperatures of the upper and lower generator air coolers. It employs nitrogen-filled helical-element systems like the one on No. 1-2 board. It likewise is equipped with two electric contact devices actuating relays to alarm signals when the air temperature reaches a pre-determined maximum.

Gate Valve Equalizer for No. 3-4 Unit. If due to some mishap it becomes necessary to shut down No. 5 boiler (which supplies this unit with steam) and it is desirable to keep this unit (3-4) in service, it could be accomplished by opening the equalizer valve admitting steam to the turbine from No. 1-3 boiler which carry the same operating pressure.

Gate Valve Equalizer for No. 1-2 Unit. Should it ever become necessary to shut down Nos. 1 and 3 boilers (which supply No. 1-2 unit with steam) for continuity of service an equalizer valve could be opened admitting steam to No. 1-2 unit from No. 5 boiler which has the same operating pressure but carries a higher steam temperature, so it becomes necessary to de-superheat this steam to obtain the proper steam temperature.

South Gate Valve Control. Should it become necessary to shut off the steam supply through the south line, tripping this switch operates a motor-driven valve closing the main.

North Gate Valve Switch. Same as preceding.

Indicating Lights for South Throttle Valve. This valve switch is equipped with three position lights, each of a different color: (1) Blue—valve in closed position; (2) White—power off; (3) Red—valve open.

Indicating Lights for North Throttle Valve. Same.

South Back Stop Valve Switch. This switch controls a valve located in the steam supply line at some distance from the turbine, nearer the steam header. This valve is used more as a double precaution against steam entering the unit while down.

North Valve Switch is identical.

Oil Level Light Indicator. A three-light system, flashing when pre-determined oil levels are reached: (1) Blue—low oil level; (2) White—normal; (3) Red—high.

Switchboard Signal. Same as used on No. 1-2 board.

Condenser Pit Signal. Same principle as on No. 1-2.

Other instrumentation items on this control panel are as follows: Mercury column vacuum gage, turbine speed indicator, throttle steam pressure gage, valve check pressure gage, first stage pressure gage, primary admission gage, polyphase wattmeter, mercury column barometer and thermometer, spill-over stop valve switch, emergency trip for back stop valve, generator air temperature alarm switch, oil temperature lights.

This makes a total of twenty-seven instruments, signals, etc., on this board.

INSTRUMENTATION OF NO. 5 15,000-KW. UNIT

THE panel board for No. 5 non-condensing turbo-generator includes instrumentation for recording and totalizing the flow of steam; indicating and recording the pressures and temperatures of the steam at important points throughout the unit; indicating and recording the temperature of the air leaving the generator air cooler; indicating the electrical load on the unit and the turbine speed. Also signal to switchboard, and signals denoting excessive generator air temperatures and low oil pressures. For protection against damage due to failure of the unit, the panel board includes safety switches for instantaneous closing of the valves in the steam lines to the unit. Inasmuch as the principal instruments on this unit are of the electrical type and similar to No. 3-4 110,000-kw. unit, no attempt will be made to describe them but references will be made to principles of operation described earlier in this article. To itemize the board let us proceed as follows:

Pressure gages: (1) Throttle steam pressure; (2) First stage steam pressure; (3) Exhaust steam pressure. I believe it sufficient to say that the gages used throughout the entire high-pressure system are of the finest obtainable. All are of the Bourdon type.

Speed indicator. Electrically-operated instrument.

Polyphase Wattmeter. Electrically-operated, single-element, 60-cycle, range 0-24 megawatts.

Steam Flow Meters. Electric type, similar to those on No. 3-4. Included are two temperature systems recording on the same chart the temperatures of the steam entering and leaving the turbine.

Switchboard Signal. Similar to those on the other turbine control boards.

Back Pressure Governor Control. A push button switch, controlling a motor-operated valve in engine exhaust steam line at the evaporators.

Gate Valve Control 20" Exhaust Switch. This switch is remote control on a motor-operated valve to open and close gate valve in engine exhaust line. It is equipped with three lights, denoting the position of valve: (1) Blue—valve closed; (2) White—power off; (3) Red—valve open.

Stop Valve Trip Switch, with glass cover, lock, hammer and chain. This switch is for emergency tripping of back stop valve in steam supply line.

Gate Valve, Exhaust Line. We have remote control on gate valve in exhaust line by push button switch. This switch is also equipped with lights indicating valve position.

Oil Level Indicator Lights. This system consists of three lights: (1) Blue—low level; (2) White—normal operating level; (3) Red—high oil level.

Indicator Lights for Throttle Valve. A two-light system: (1) Red—valve open; (2) Blue—valve closed.

Exhaust Valve Control Switch. This switch is used to operate motor-driven gate valve in a 4" exhaust line. This 4" line exhausts to atmosphere and is used only during the warm-up period.

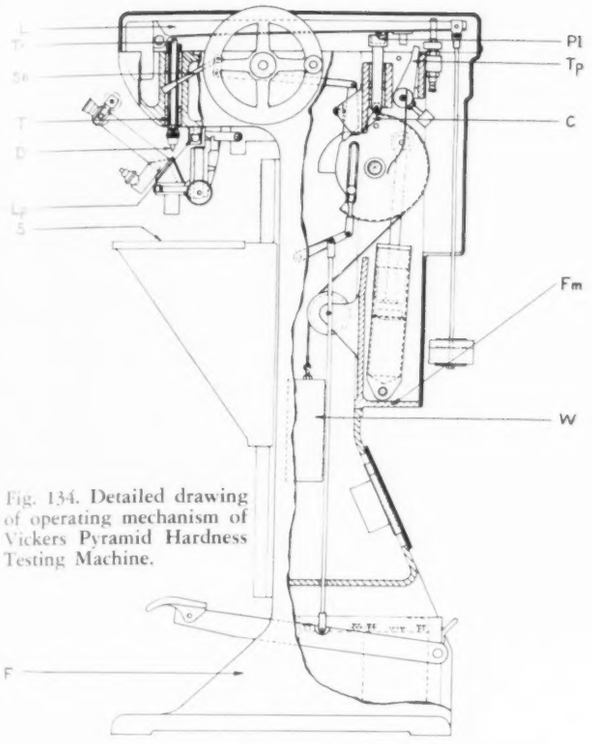


Fig. 134. Detailed drawing of operating mechanism of Vickers Pyramid Hardness Testing Machine.

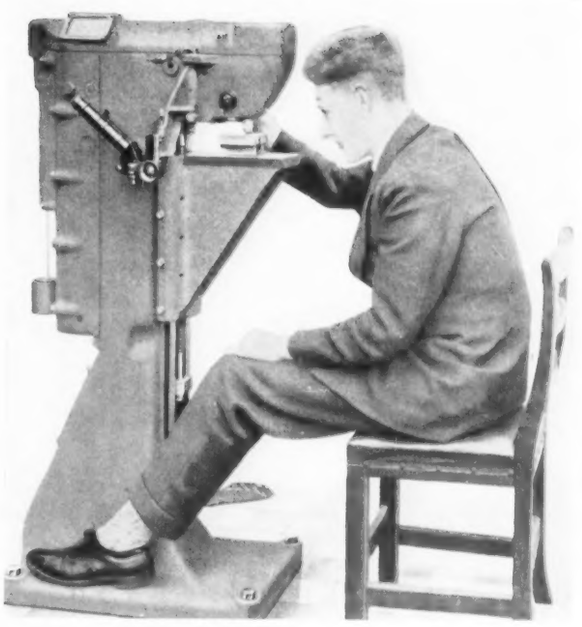


Fig. 135. The Vickers Diamond Pyramid Indenter Hardness Tester in use. Microscope turned back out of way.

Pyramidal Indenter Hardness Testers

(concluded)

By S. R. WILLIAMS

Professor of Physics, Amherst College

In Fig. 134 the Vickers machine is shown diagramatically. It consists of a main frame *F* of U section which carries the stage *S* and the lever *L* of 20-to-1 ratio. By means of this lever a load is applied through a thrust rod *Tr* to the indenter *D* at the lower end of the tube *T* which moves up and down freely in a vertical position. Fig. 135 shows the machine in use. The control mechanism is all contained in the smaller section of the frame *Fm*. The plunger *Pl* moves up and down vertically under the influence of a rotating cam *C* which applies and releases the test load. The cam is mounted on a drum and when the starting handle *SH* has been depressed, the whole is rotated by a weight *W* attached by a flexible wire, the speed of rotation being controlled by a piston and dashpot of oil. The mechanism provides for a slow and diminishing rate of application for the last portion of the load. Depression of the foot pedal returns the cam, drum and weight to their original positions. A tripping piece *Tp* supports the beam during the return of cam, drum and weight. The machine is then ready for a new test.

The microscope, for measuring the diagonals of the square impression, reads directly to 0.001 mm. on a large micrometer drum, and measurements at right angles to each other can be taken without moving the testpiece. Fig. 136 shows an Amsler-Vickers machine in which the measurement of a diagonal is being performed. There are three knife edges in the eye-piece, one of which is fixed, another movable by means of a micrometric screw connected to a counting mechanism, while a third is provided for rapid readings to specified limits. The left-hand corner of the impression, as it appears through the microscope, is set by means of centering screws to correspond with the left-hand or fixed-knife edge, while the knife edge controlled by the micrometer screw is then adjusted to correspond with the right-hand corner of the impression, the whole then appearing as shown in Fig. 137.

In cases where the work has to be tested with a view to ascertaining whether it conforms to specified maximum and minimum limits of hardness, a third knife edge is brought into use. This third knife edge is set by means of special screws to correspond with the smaller dimension, *i.e.*, the maximum limit of hardness, while the knife-

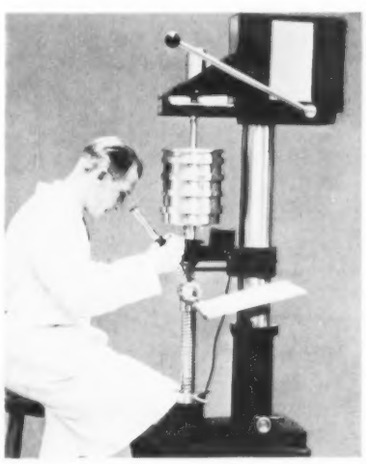


Fig. 136. The Amsler-Vickers machine. Type No. Di H 194. The operator is shown measuring an indentation in a milling cutter; the measurement is made without changing the position of the test-piece, after the test-load is automatically lifted at the end of the adjustable test-cycle. (H. A. Holz, New York)

Fig. 137. The area of the imprint is obtained from measurements on the diagonals of the square.

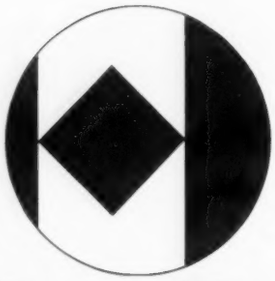


Fig. 138. Use of microscope in checking the upper and lower limits of the hardness specified in a given grade of steel. Vickers Pyramid Hardness Testing Machine.

edge controlled by the micrometer screw is adjusted to correspond with the larger dimension, *i.e.*, the minimum limit of hardness. Having made the settings of the second and third knife edges in this manner it is only necessary, when making an observation, to set the fixed knife edge to the left-hand corner of the impression in the ordinary way. If the right-hand corner of the impression appears between the second and third knife edges as shown in *B*, Fig. 138, then the material has the proper hardness for the range indicated. In Fig. 138, *A* shows a material too hard to pass inspection, while *C* is what one observes when the material is too soft and must be rejected.

In the Vickers machine the duration of the load is controlled automatically and is always applied and removed in exactly the same manner. Errors due to inertia and momentum are therefore eliminated. This machine may also be used with a ball indenter and thus give regular Brinell impressions.

The Amsler-Vickers machine has another advantage in that the point, at which the indenter contacts the surface of the material to be tested, may be thrown on a ground glass screen directly in front of the operator. The lengths of the diagonals may be read directly, which adds to the rapidity and convenience of operation, and at the same time facilitates the correct performance of the test. This form of the Vickers is shown in Fig. 139.

The "Diamo-Brinell" Hardness Tester, Fig. 140, has a diamond pyramid indenter. It is put out by the Pittsburgh Instrument and Machine Co. of Pittsburgh, Pa. Fig. 140 shows how, by means of a system of weights and levers, a load is being applied to the indenter in order to measure the hardness of a milling machine cutter. The microscope for measuring the diagonals of the square impression is turned to one side so as to be out of the way.

An important feature of any hardness tester is that the load be applied slowly and uniformly and always in the same way. This is accomplished automatically in the Pittsburgh instrument.

Inasmuch as this machine is another American version of the English Vickers instrument, it will be found that the operation is quite similar to that of the Vickers machine. All testers of this type are designed for measuring a wide range of hardness and all are suitable for measuring the hardness of thin materials. The Diamo-Brinell testing machine has found a wide use in the shops of the U. S. Navy.

Messrs. Thomas Firth and John Brown, Ltd., of Sheffield, England, put out a hardness tester (the Firth Hardometer) which also makes use of a diamond pyramid indenter with an angle of 136° between opposite faces as was used in the Vickers machine. This tester is also arranged to use a steel ball indenter if desired.

The load is applied by means of a handwheel through a specially calibrated spiral spring. When the correct load has been imposed a trip mechanism removes the load and the dimension of the imprint may then be measured by means of a microscope. The machine operates on the Brinell principle, that is, it makes an indentation and then measures the diameter of a circular imprint or the diagonal of a square imprint.

The Firth Hardometer works with light loads and so the imprints are not deep. It is intended primarily for measuring the hardness of nitrided surfaces, thin sheets and small objects.

Tinius Olsen Testing Machine Co. of Philadelphia, Pa., also puts out a Hardometer, similar to the one just described. Fig. 141 shows this Olsen machine.

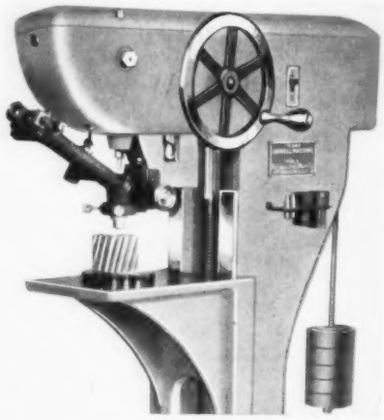


Fig. 139. Reflex-Vickers Hardness Tester. (H. A. Holz, New York)
Fig. 140. The "Diamo-Brinell." (Pittsburgh Instrument & Machine Co.)

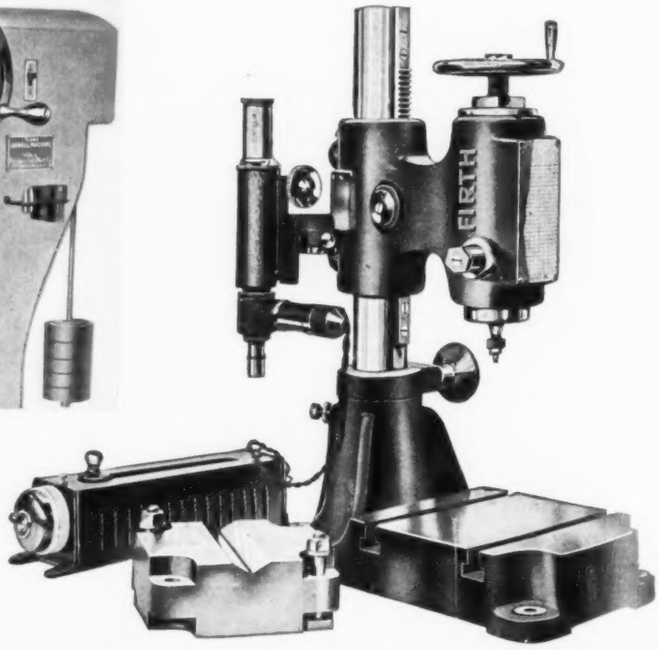


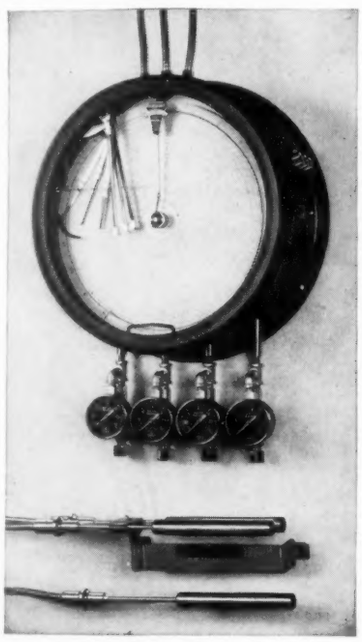
Fig. 141. The Firth Hardometer. American model (Tinius Olsen)

THE MONTH'S NEW INSTRUMENTS

(Continued from Page 181)

Multiple Zone Control For Dry Kiln Operation

A new multiple zone control unit, particularly adapted for long kilns, automatically provides even heat and humidity over entire kiln length. Essentially a Triplex controller, unit has three bulbs, three complete thermal systems, three set pointers and three control heads. It provides individual temperature control at each end of the kiln by two separate dry-bulb systems; the third, or wet bulb, is used for humidity control of the entire kiln. All three temperatures are recorded continuously on one chart. In progressive kilns, new controller can be applied to control, recording the temperature in all three zones. For fan kilns of reversing type, twin dry bulbs are connected to each control system, the control always being operated from the hotter of the two bulbs. Damper control can also be supplied with this instrument so that, if humidity continues to rise after spray is shut off, controller will open a damper.—*The Foxboro Company, 46 Neponset Ave., Foxboro, Mass.*

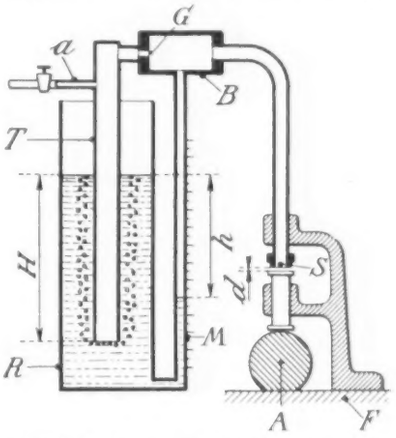


Vibration Pickups

New Models "61B" and "62B" Vibration Pickups employ piezoelectric principle for measurement and analysis of vibrations in industrial fields. Piezoelectric element is a grafoil bimorph Rochelle salt crystal unit with special-process moisture-proofing. Crystal element is inertia actuated, obviating need of a stationary reference body. Isolated mounting gives maximum protection against breakage of crystal. Assembly is enclosed in cast aluminum case. Output voltage is proportional to vibration due to acceleration throughout the linear range of each pickup, giving a relative measure of the stresses set up by the vibratory motion. Model 61B has a linear voltage-acceleration characteristic up to approx. 1000 c.p.s., for general vibration studies. Model 62B has a voltage output about four times that of the 61B and a linear characteristic extending to 500 c.p.s., for applications such as direct energizing of headphones or oscilloscopes, which require a relatively high output voltage. Both are responsive beyond the linear range, to frequencies up to approx. 3000 c.p.s. Each pickup is equipped with a stationary mounting bracket and a screw for the $\frac{1}{4}$"-28 thread in the pickup shank. Other accessories included are a ball-tip, point-tip, and 8" extension rod.—*Shure Bros., 225 W. Huron St., Chicago, Ill.*

Pneumatic Micrometer

For measurement of bores, orifices, diameters, thickness, and length, "Solex Pneumatic Micrometer" makes use of pneumatic rather than mechanical or optical magnification. An air controller supplies air at constant pressure through



a fixed jet to an air chamber and then to an arrangement of outlet orifices depending on application. Pressure in air chamber, indicated on a vertical manometer integral with instrument, is a function of size of outlet orifice or amount of air escaping through it. When diameters are measured, outlet orifices are disposed on diameter of a plug which fits into the bore. Difference in size between this plug and the bore being measured is amplified several thousand times on the micrometer scale. Areas of orifices up to 0.07" are measured directly without accessories. When external diameters, thickness, and length are measured, a valve-and-stem device is used. It is said that measurements are accurate to 0.00003", require no experience on part of operator.—*The Pneumatic Gage Co., Shoreham Bldg., Washington, D. C.*

IT'S THE "*Sucker*" WHO PAYS AND PAYS!

The "sucker" is the man who chisels the price down and expects to get more than he pays for. IT' JUST CAN'T BE DONE.

The quality of PALMER thermometers is never sacrificed and when you buy a PALMER thermometer, you know that it has been properly annealed so that it will not change with age or use. (Annealing is something you cannot see.)

SO YOU CAN'T GO WRONG WITH PALMER

"Red-Reading-Mercury" Quality Thermometers.

A PALMER Thermometer with the selected wide RED column means less chances of error and quicker reading of temperature. (It's pure mercury with reflected RED COLOR)

Note:—"Red-Reading-Mercury" is furnished on all new thermometers as well as REPAIRS to all makes—at no extra cost. Specify PALMER on your next order.

(Send for Catalog No. 300-B)

THE PALMER COMPANY

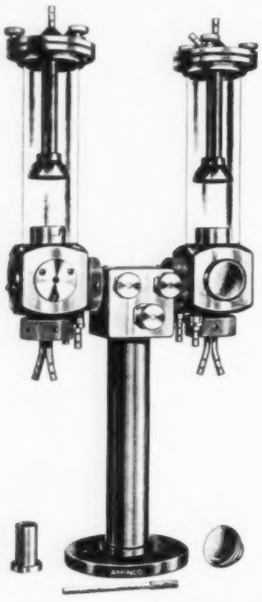
Manufacturers—A.S.T.M., Laboratory and Industrial Thermometers.

2511 NORWOOD AVE., CINCINNATI, NORWOOD, OHIO

Canadian Plant: King & George Sts., Toronto.

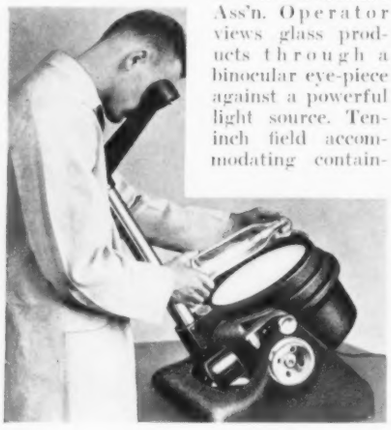
X-ray Tube; Powder Spectrum Camera

Aminco Ion Type X-Ray Tube is said to provide a reliable, steady, and powerful source of homogeneous (monochromatic) or heterogeneous (white) x-radiation for diffraction and crystal structure study, metallurgy, and chemical x-ray analysis. It is available in single- and double-tube units, each tube being provided with three windows; thus three or six radiographs are obtainable independently or simultaneously. A new powder spectrum camera for use with the new tubes is also announced.—*American Instrument Co., 8010 Georgia Ave., Silver Springs, Md.*



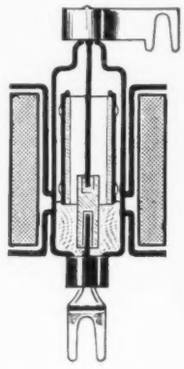
Glass-Test Polariscope

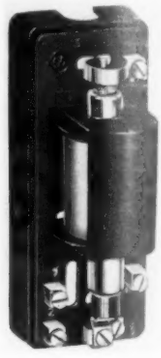
New type of polariscopic strain tester, said to be the most sensitive machine of its kind ever developed, was designed to specifications set by Testing Committee of Glass Container Ass'n. Operator views glass products through a binocular eye-piece against a powerful light source. Ten-inch field accommodating containers up to one-gallon size. Brilliant strain colors are said to be more intense than has ever been possible before, minimizing eye fatigue. With Polaroid Strain Testing Spectacles, several observers can view an object at same time, for discussion of questionable specimens, training new operators, etc. Tester is water-proof, shock-proof, dust-proof. Polarizing assembly is protected from breakage by a thick sheet of unbreakable transparent plastic, and mounted in shock-absorbing gaskets.—*The Polaroid Corp., 101 Columbus Ave., Boston, Mass.*



Mercury Plunger Relays

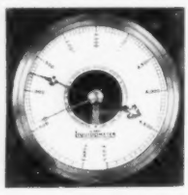
"Vertex Non-tilting Vertical Mercury Relay" has all moving parts sealed in glass, operates noiselessly and more quickly than mercury switches requiring tilting. Regular model (illustrated) consists of vertical tube containing steel plunger floating on mercury bath. Tube is surrounded by solenoid which, when energized, pulls plunger downward, thereby raising level of mercury so that it makes contact with upper electrode (see diagram). Another model has a light armature (instead of a cylindrical plunger) bridging two mercury pools: it is designed for high frequencies of operation. Sizes and models for wide ranges of capacities and of operating speeds.—*F. Loewenberg, 10 E. 50th St., New York City.*





INSTRUMENT MAN AVAILABLE

Technical training, plus 12 years of Electrical and Instrument Experience. At present employed as Instrument Foreman in a large oil refinery. For 1ST class references and complete record of experience, without obligation Write P. O. Box 107, Arkansas City, Kansas.



LIQUIDOMETER SENIOR

TANK CONTENTS GAUGES
FOR ANY LIQUID THAT FLOWS

LIQUIDOMETERS
100% automatic in operation. Liquid level changes instantaneously indicated or recorded without using outside source of power. Remote Reading models utilize an ingenious temperature compensated hydraulic transmission system, permitting long lengths of transmission tubing exposed to varying outdoor temperatures. All Liquidometers are float operated, eliminating use of pumps, valves, etc. and errors due to specific gravity differences.

LEVELOMETERS
Utilize hydrostatic principle of establishing a balance between the head of the liquid in a tank to be measured and the indicator located at a remote point. Dial type indication with large easy to read numerals and graduations. Precision built with knife edge-bearings, they are rugged, easy to install and constructed of the finest materials.

Liquidometers and Levelometers are made in a variety of sizes both in indicating or recording types to suit any depth of tank or capacity.

Write for literature

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE., LONG ISLAND CITY, N. Y.

Optical DESIGN AND CONSULTATION

P E M

SOME of your problems are being solved by mechanical, electrical and chemical engineers. To fill the "optical" gap is our purpose. Many industries find this service surprisingly economical and productive of RESULTS, particularly in the development of new products and in methods for the control of production.

PERKIN, ELMER & MOFFITT
90 BROAD STREET, NEW YORK

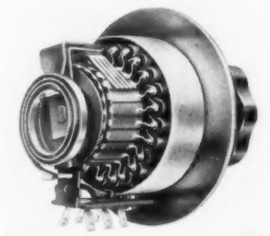
"Required Reading" for Instrumengineers
Fundamentals of Instrumentation
Useful data on Automatic Control $2.00 postpaid
INSTRUMENTS PUBLISHING CO. Pittsburgh

TEMPERATURE TESTING EQUIPMENT
CLAUD S. GORDON COMPANY — Cleveland — Chicago — Indianapolis

LIFE is intrusted with confidence to LITTELFUSES the world over. They protect valuable instruments. Also radio, auto, high voltage, aircraft fuses—mountings of all types. Write
LITTELFUSE LABORATORIES 4250 Lincoln Ave. Chicago, Ill.

20-step Attenuator

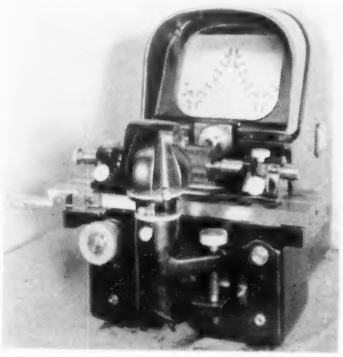
Instead of usual stud type switch, new 20-step "Type A-21" utilizes a molded rotor commutator with conducting segments of polished hard-drawn copper



molded in phenolic, multi-finger beryllium copper contact (see *Instruments* July 1936, page 178) and a flat spiral spring connector (see *Instruments*, Nov. 1937, page 275), is said to maintain its initial low noise level of –150 db in service. New combination of features is said to assure the utmost in quietness and dependability. Attenuator is 2" long and 2" in diameter. Attenuation range is linear from 0 to 45 db, in steps of $2\frac{1}{2}$ db, tapering from 45 db to infinity in last 2 steps. Other ranges with or without detent action are available. Standard terminal impedances are 50, 200, 250 and 500 ohms; other values on special order. Removable aluminum cover protects unit against dirt and provides electrostatic shielding.—*International Resistance Co., 401 N. Broad St., Philadelphia, Pa.*

Bench Comparator

Completely redesigned optical-projection bench model comparator is available in two styles: (1) with a plain table holding staging fixtures for comparing magnified shadow against a master outline on screen; (2) with a 16" movable table for measuring lead or spacing.

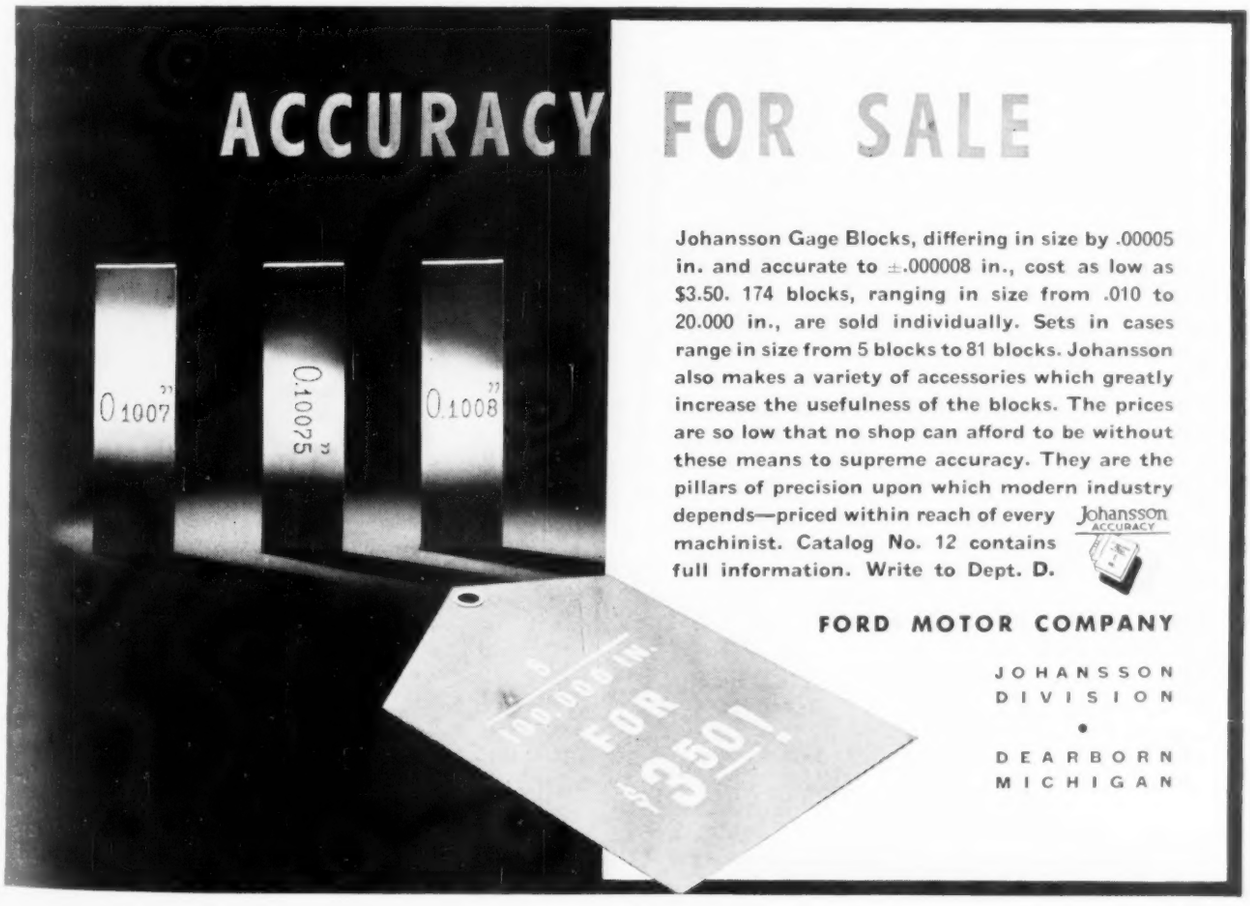


Lead measurements up to 2" at one setting may be accomplished by use of micrometer, end measuring bars or spacing blocks. Standard micrometer is graduated in 0.0005"; one graduated in 0.0001" can be supplied. Standard centers and center blocks will stage objects 3" diam. × 11" long. V-block stages and vise fixtures also supplied. Lenses may be supplied to give the following magnifications: 90×, 50×, $31\frac{1}{4}$×, 16× and 10×.—*Jones & Lamson Machine Co., Springfield, Vt.*

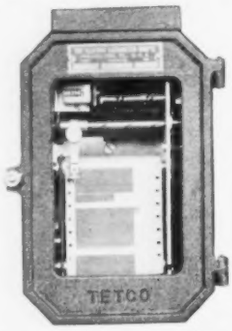
Line Equalizer Panel

Exceptional flexibility of adjustment is claimed for a new line equalizer panel, known as AmerTran Type F-188, designed for correcting frequency charac-

teristics of circuits for transmission and amplification of speech and music—especially discontinuous-service lines not justifying installation of a fixed equalizer network. On low side, equalization at 25, 50 or 100 cycles can be controlled throughout a range of 0 to 25 db in eleven steps; same type of control on high side for 5, 7, 8 or 10 kc.; also an 11-step, 30-db master attenuator which controls insertion loss at 800 cycles and determines maximum available equalization. The five controls on panel enable quick adjustment to any one of 15,972 inverse frequency characteristics. Unit is designed for operation to +20 db; offers a nearly constant impedance of 500 ohms without introducing appreciable harmonic distortion. Panel permits mounting on a standard 19" relay rack.—*American Transformer Co., 178 Emmet St., Newark, N. J.*


ACCURACY
FOR SALE
0.1007"
0.10075"
0.1008"
FOR $3.50!
Johansson Gage Blocks, differing in size by .00005 in. and accurate to ±.000008 in., cost as low as $3.50. 174 blocks, ranging in size from .010 to 20.000 in., are sold individually. Sets in cases range in size from 5 blocks to 81 blocks. Johansson also makes a variety of accessories which greatly increase the usefulness of the blocks. The prices are so low that no shop can afford to be without these means to supreme accuracy. They are the pillars of precision upon which modern industry depends—priced within reach of every machinist. Catalog No. 12 contains full information. Write to Dept. D.
Johansson
ACCURACY
FORD MOTOR COMPANY
JOHANSSON
DIVISION
DEARBORN
MICHIGAN

TETCO
Speed Recorder



Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced.

The Electric Tachometer Corp.
1358 Spring Garden St., Philadelphia, Pa.

HARDNESS TESTING...

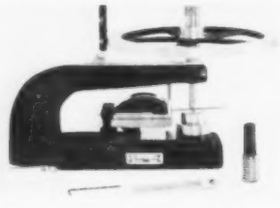
done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 30 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

Illustrated bulletins free.

The Shore Instrument & Mfg. Co., Inc.
9025 Van Wyck Avenue, Jamaica, N.Y.

THICKNESS VARIATIONS?
Use The
LIGHT WAVE MICROMETER



It measures: Paper, Rubber, Leather, Textiles, Films, Wire, Precision parts.

This instrument duplicates readings to 0.00001" and measures at any pressure from 0 to 2½ pounds. Range 0 to 1" or 0 to 2".

Write today for circular M30.

THE VAN KEUREN CO.
WATERTOWN, MASS.

INSTRUMENTATION FORUM

PROBLEMS — SOLUTIONS — DISCUSSIONS

MAY PROBLEM (No. 19)
TEMPERATURES OF LIVING TISSUES

Biologists have to measure accurately the temperatures of different portions of a single animal's anatomy. One problem is the accurate measurement of temperature DIFFERENCES between outer and inner cell layers, often less than 0.001" apart, requiring thermocouples or resistance "bulbs" of almost microscopic dimensions, which can be inserted with least irritation and which animals can "get used to."

$5 PRIZE SOLUTION
By S. H. ISAACS
COVINGTON, KENTUCKY

Leeds & Northrup make a thermocouple in the form of a No. 17 hypodermic needle, could probably make smaller ones to meet the cytological requirements. . . . It would be necessary to calibrate pairs of couples to measure the temperature differences suggested in the statement of the problem. This could easily be done with laboratory apparatus.

$ PRIZE DISCUSSION
By G. F. LAING
CHICAGO, ILLINOIS

If the thermal conductivity of cell tissue is assumed to be approximately equal to that of water, and if it is further assumed that a temperature gradient of 5°C. per inch of cell tissue is obtainable for measurement, it will be apparent that measuring points placed 0.001" apart in the tissue would show temperature differences of only 0.005°C. even though the transfer of heat through the tissue is approximately 0.042 calories per square centimeter per minute. Although the sensitivity and accuracy of temperature measurements were not specified in the problem, if the above assumption is at all reasonable it will be seen that there is no commercial instrument available which will even approach the sensitivity required by the biologist.

[Mr. Laing nevertheless submits a diagram and description. The description begins: "If the area of thermocouples could be made sufficiently small . . ." This part, therefore, is not accepted for publication. His discussion, *constructively negative*, is accepted.—EDITOR]

MARCH PROBLEM (No. 17)
CHLORINE-CONTENT CONTROL

Large chemical company desires to make its (manual) chlorinators into automatic differential chlorine controllers, requires device for measuring chlorine content of chlorinated water (up to 30 p.p.m.) and actuating the control system.

[At last, at the end of June, we learn why the engineers (of the inquiring company) whom we had appointed as consultants had kept us waiting so long for their verdict. A letter from the purchasing agent of the inquiring company informs us also that we can hardly hope to obtain, directly from these engineers, separate opinions on the merits of the solutions and discussions submitted. Their only comment is that no solution fulfilled the requirements.

As we had expected, the solutions and discussions suggested either the colorimetric or the conductivimetric method (and one proposed both). All entrants gave evidence of awareness of some sources of error, and therefore, in spite of the adverse opinion rendered by the engineers of the chemical company, and in spite of the fact that these engineers have installed a system devised jointly by them and by an instrument company, *before* they saw the problem entries, we award honorable mentions to all entrants. They are:

W. C. Gardiner, Niagara Falls, N. Y.
John M. Meyer, San Francisco, Calif.
H. Olken, Cambridge, Mass.
William Weber, Philadelphia, Pa.
Stanley T. Wepsic, Akron, Ohio

Ever since, shortly after the closing date, we read and compared the solutions and discussions, we knew that it was a case of "all or none" with regard to accepting solutions and discussions for publication. All entrants worked out some details but none seemed sure that his particular scheme or schemes would work. We shall try to have some engineer in the employ of the chemical company, or of the instrument company, disclose the method jointly devised. We do not know how soon this much-desired publicity can be given, however, for it seems that patent applications are involved.—EDITOR]

Problem No. 20 — Subject Index 2.02

RECORDING SPEED VARIATIONS

"We have drum type machines which move with a peripheral speed of approximately 25cm./sec. The speed shows approximately 6 variations per second, due to gearing and other causes. We wish to measure accurately the magnitude and frequency of these variations. The method we now use—time intervals inscribed by means of a small motor—is cumbersome, and doesn't lend itself to a continuous check-up. We thought of various differential methods: comparing the varying speeds with a uniform speed produced by an electric motor or similar means. The recording, however, of six variations per second has been a difficult problem. An oscillograph might show these variations, but since they are not uniform it will hardly be possible to get a continuous record." . . . Five dollars will be paid for every solution (or discussion clearly pointing the way to a solution) which is accepted for publication. Address Instrumentation Forum, 1121 Wolfendale St., Pittsburgh, Pa. Type double-space, on one side of paper. Draw diagram in black ink on separate sheet. Mail before August 15. Solutions and discussions accepted will appear in September 1938 issue.